THE WORLD HISTORY OF Beekeeping AND Honey Hunting

Eva Crane

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This book is dedicated to the memory of
all those in past generations who
worked with bees and
learned about them.

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Preface

This book represents the first attempt to write a world history of people's use of social bees: how bees' nests were initially hunted for their honey and wax and, later, how the bees were kept in purpose-made hives. Evidence survives from early times in the form of artefacts, pictures and written records, and also human traditions of dealing with bees. Since 1949 I have had opportunities to travel in over sixty countries, and to see traditional and modern hive beekeeping and also honey collection from nests. I learned much that helped me to piece together some of the long history in the different continents.

When visiting certain places, and when writing many Sections of the book, I realized my good fortune in being one of the first generation of people able to travel speedily by air to distant countries and, with relative ease, to visit rather remote areas of them. And I also came to realize that mine is probably the last generation able to see the world's rich variety of traditional beekeeping, and to talk with those who inherited its techniques and skills from their forefathers. By the 1980s the parasitic honey bee mite *Varroa jacobsoni* had been spread to many countries, killing colonies of bees living wild or in traditional hives.

In *The archaeology of beekeeping* (1983) I described some recent discoveries which substantially increased our knowledge of early honey hunting and beekeeping, and the book stimulated more searches. Further finds have now been made by specialists in fields such as archaeology, ancient and mediaeval history, anthropology, ethnology and philology. Examples are:

- Mesolithic rock paintings of honey collection in Europe and Asia
- beeswax paintings by Aborigines in Australia from 2000 BC
- a method from the AD 200s – still practised in north Vietnam – for inducing a swarm of Asian honey bees to settle in a hive
- hives or hive parts around two thousand years old, excavated in widely separated Mediterranean areas and in Mesoamerica.

I hope that this book will help modern beekeepers to appreciate the wealth of traditions on which their industry is ultimately based. The foundation of modern beekeeping was laid in North America during the second half of the nineteenth century, after two hundred years of effort and experiment in Europe during the scientific revolution. Where further new principles and management techniques have been applied during the twentieth century, the book extends the history to its recent end-point. I described the current status of these developments in *Bees and beekeeping: science, practice and world resources* published in 1990.

In attempting to make a synthesis of what is now known about the history of harvesting from bees, I became involved with a range of topics and languages outside my personal expertise, and I hope that remaining errors and omissions in the text will be forgiven. I frequently had to work at the limits of my own knowledge, but was greatly helped by specialists in various subjects, some of whom are mentioned in the Acknowledgements.

The amount of factual information available varies enormously from country to country. For some, a large mass of historical records exists which could be represented by only a small selection, whereas for some others almost nothing could be found. In dealing with important aspects of early history where knowledge is scarce or questionable, I marshalled what evidence I could find and provide a suggested reconstruction of developments in a separate Section. I hope that these conjectures will stimulate some readers to seek further evidence from artefacts and written records, and also from biogeography. Among the most intriguing puzzles are the originations of hive beekeeping in Egypt, Greece, Rome, the upper Indus basin and Mesoamerica, and also the origination of top-bar movable-comb hives in Greece and in the mountain range which marks the border between China and Vietnam.

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I am grateful to photographers and artists named in Figure captions for permission to reproduce their illustrations, and I hope that the few who could not be traced will not object to the use of their material.

I owe a great deal to my colleague Penelope Walker who worked with me in compiling and organizing the book, improving its structure and clarity, and providing support in many other ways. And I much appreciate Sandra Braithwaite's orderly work in processing the many drafts of text and tables.

I valued the friendly co-operation of Colin Haycraft of Duckworth until his untimely death in 1994, and since then of Deborah Blake and Ray Davies.

During my travels in different countries I received much hospitality and help in other ways from many people, including specialists in different subjects and translators – particularly for Asian and African languages. The visits were often arranged in conjunction with professional assignments to lecture or to advise on beekeeping, bee research or honey.

The work on which much of the book is based could not have been done without the support and generosity of spirit of my husband James Crane, who died in 1978.

Note

The use in this book of 'man' and other apparently gender-linked terms relating to human beings is explained at the beginning of Chapter 6. However, throughout the centuries there have been differences between men's and women's relations with bees, and these are explored in Chapter 53.

1

The Structure of the Book

This book presents a world history of the methods by which people used bees as a resource and succeeded in managing them. In many societies honey was sacred, and in some the bees themselves or the wax they produced. Early hunter-gatherers and succeeding generations valued honey as a sweet food and a medicine. Hives were probably first used for bees between 5000 and 3000 BC. The search for a 'rational' system of beekeeping began only a few centuries ago, and in 1851 it culminated in the production of a practical movable-frame hive which led to the establishment of a worldwide beekeeping industry.

The book deals with the subject diachronically, and follows through each stage of honey harvesting until a subsequent stage superseded it – or where necessary up to the present. Table 1.1A summarizes the sequence of the stages for the honey bee most commonly kept in hives, *Apis mellifera*, and for the most productive Asian honey bee *Apis dorsata* which nests in the open. Each Part of the book from II to VIII deals with a single stage of development in different geographical regions; even the most primitive stages still exist somewhere in the world and have been observed and studied. Table 1.1B leads to Sections of the book on various stages of harvesting from the world's different honey-producing insects.

Names and boundaries of many countries have been changed over the centuries, and information is usually entered under the present name, except that the alternative Persia is used for Iran.

Use of the term 'beekeeping': In this book the hunting of natural nests of bees and the collection of honey from them are not included under 'beekeeping'; the term is limited to keeping bees in hives (Parts V to VIII) or in other purpose-made nest sites which include cavities in trees, rocks and walls (Chapter 16).

Part I. Setting the scene
Chapters 2-5

Part I provides background information on the lives and habits of the world's honey-storing insects; it may not be needed by readers familiar with the biology of bees. Chapter 2 refers to the evolution of the insects; all are social and live in colonies, each with a queen and many infertile females known as workers and also some males (drones) in the reproductive season. Honey-storing bees include at least nine species of honey bees (*Apis*) and 500 or more species of stingless bees (Meliponinae). Chapter 3 explains their world distribution; honey bees are native only in the Old World, and stingless bees only in the tropics. (In addition, certain social wasps store honey, and bumble bees and honey ants store small amounts.) Chapter 4 considers the characteristics of honey bees in relation to man's use of them, and Chapter 5 describes animals which also feed on honey bees or their products.

Part II. Opportunistic honey hunting by man
Chapters 6-13

Hunter-gatherers practised opportunistic honey hunting, the most primitive stage of harvesting (Table 1.1A). Mesolithic and later rock paintings show early methods, and recent studies of hunter-gatherer peoples using similar techniques have brought these early scenes to life. The nests searched for were usually in trees or rocks, or underground. In some regions bee brood – a food rich in protein – was valued even more highly than honey. Certain societies used the wax from the bees' combs for many purposes, but others discarded it.

In areas where hive beekeeping had started, natural nests were often hunted to get bees to populate hives.

Part III. History of collecting honey from owned or tended nests
Chapters 14-17

Ownership of land probably developed during the Neolithic period. Individuals or communities might then own bees' nests or nest sites, and tend them to some extent. The nest was protected if necessary; at harvesting, the colony was preserved and in some cases it was provided with food to prevent starvation.

An owner might improve his access to nests in trees by inserting climbing pegs, and cutting a door to a nest cavity. In trees or soft rock, he might also provide additional nest sites by making new cavities or by enlarging existing small ones. Chapter 15 discusses the collection of honey from owned nests of Asian honey bees, including species which nest in the open.

Part IV. Honey bees that nest in the open: tending and beekeeping Chapters 18-19

In a few localities in Asia, artificial outdoor nest sites were made for colonies of honey bees which nest in the open, and a form of beekeeping was done with them.

Part V. History of traditional beekeeping using fixed-comb hives Chapters 20-32

Part V starts the history of the mainstream development of hive beekeeping, which occurred in the Old World where honey bees were native. Purpose-made hives were probably used in Egypt for colonies of the cavity-nesting honey bee *Apis mellifera* between 5000 and 3000 BC, and in China and Vietnam for the rather similar Asian species *Apis cerana* before AD 200. The history of beekeeping during and after classical times is relatively well documented.

In one part of Central America stingless bees were also kept in hives from Ancient times (Chapter 30). Beekeeping with honey bees started in the New World during the 1600s (Chapter 31) when early settlers took hives of *A. mellifera* from northern Europe.

A hive for cavity-nesting bees needed one or more small flight holes for the bees and, for the beekeeper harvesting honey combs, either an open base or a large removable closure. As in a natural nest cavity, honey bees attached their combs to the hive, and with all such fixed-comb hives the beekeeper had to break or cut the combs away, although different beekeeping methods were developed in different regions. In some temperate regions beekeepers captured swarms that issued from their colonies and used them to populate

Table 1.1A

Chronology of stages in the harvesting of honey and wax from the honey bees *Apis mellifera* and *Apis dorsata*

Book Part	*Stage*	*Likely starting period; region (First known record)*
Cavity nests of *Apis mellifera*		
II	opportunistic hunting	Palaeolithic or earlier; widespread (Mesolithic, Spain)
III	collection from owned nests	Neolithic, widespread
	tree beekeeping	2000-1000 BC; mid-Volga region, Europe (AD 900, Poland)
V	beekeeping using traditional fixed-comb hives:	
	horizontal hives	between 5000 and 3000 BC; Egypt (c. 2400 BC, Egypt)
	upright hives	unknown; N European forests (c. AD 200, N Germany)
VII	beekeeping using traditional movable-comb hives	unknown; Greece (1678, Greece)
VIII	beekeeping using effective movable-frame hives	1851; USA (1851)
Nests of *Apis dorsata* built in the open		
II	opportunistic hunting	Palaeolithic or earlier; tropical Asia (Mesolithic, Madhya Pradesh, India)
III	collection from owned/tended nests	Neolithic?; tropical Asia
IV	beekeeping using artificial nest sites	unknown; SE Asia near China Sea (1851, Borneo; 1902, S Vietnam)

empty hives. In the tropics, a colony was likely to move as a swarm between two flowering areas in the course of each year, and at the appropriate season beekeepers put out empty hives to attract incoming swarms.

The construction of an apiary, where a beekeeper kept his hives of bees, depended on characteristics of the region, for example building materials and the animals or weather against which protection was needed (Chapter 32). A small number of hives might be kept near the dwelling house.

Part VI. History of practices in both traditional and movable-frame beekeeping Chapters 33-37

Some beekeeping practices with *Apis mellifera* originated early and continued up to the present, whatever type of hive was used. For instance various measures were taken to guard against bees stinging the beekeeper (Chapter 33); a common method was to pacify the bees with smoke or another agent before their hive was opened (Chapter 34). Hives were 'migrated' from one area to another to utilize extra honey flows (Chapter 35). During the last few centuries different species and races of honey bees were transported between different parts of the world (Chapter 36), and this had some far-reaching consequences – especially in the Americas to which European honey bees were taken in the 1600s, and tropical African honey bees in 1956.

Observation hives with windows (Chapter 37) were devised from Roman times onwards.

Part VII. Development of beekeeping using more advanced hives Chapters 38-40

Even in Antiquity beekeepers improved their hives for *Apis mellifera*, so that they could work with the bees more easily and more effectively. An early improvement was the addition of a separate honey chamber to a hive (Chapter 38). Chapters 39 and 40 follow the improvements in hives from the 1600s up to 1851 when Langstroth devised the first practical modern type, a movable-frame hive. This hive contained framed combs distanced from each other and from the hive walls by a 'bee-space', so that each frame was 'movable' and any framed comb could easily be lifted out.

Table 1.1B

Key to Chapters and Sections on different harvesting techniques, from nests of different insects

In the final two columns *Pollination* = management for pollination; *Transport* = transport from one region to another.

	Biology	*Honey hunting*	*Bee hunting*	*Owning*	*Tending*	*Hive beekeeping*	*Pollination*	*Transport*
Cavity-nesting bees								
Apis mellifera:								
temperate-zone	2.4,3.2.4	7,9,12	7.5,9.34,12.22	14	16	20-27,31	45	36.2-36.5
tropical	2.4,3.2,4	8,12.3,12.4	8.8	14.3	16	28,36.63	45.5	36.6
Apis cerana	2.4,3.3	10.31	10.32	15.3	16	29,39.4,39.52	45.5	36.7
stingless bees (Meliponinae)	2.2,3.6	8.9,10.5,11		17.2	17.2	30	45.63	36.81
bumble bees (*Bombus*)	2.3,3.7	13.2		17.3	17.3	17.3	45.61	36.82,45.4
solitary bees		13.5					45.62	36.82
Open-nesting bees								
Apis dorsata	2.4,3.4,4.5	10.2		15.2	18.1	18.31		36.7
Apis florea	2.4,3.5	10.4		15.4	19.2	19.3		36.7
Other insects								
honey-storing wasps	2.5,3.8	13.3		17.4	17.4			
honey ants	2.6,3.9	13.4		17.5	17.5			

Part VIII. Development of beekeeping using movable-frame hives
Chapters 41-45

Methods of management for *Apis mellifera* in movable-frame hives were worked out during the second half of the 1800s. Chapter 41 describes the impact of this hive in different parts of the world, and Chapter 42 explains the part played by Beekeepers' Associations of various countries in promoting its effective use. New specializations were originated in the 1900s, and some are still being developed (Chapter 44). Examples are methods of large-scale queen rearing – including instrumental insemination of queens – and the production of package bees. Hives of honey bees were hired out to pollinate crops, and bumble bees and solitary bees were also reared in large numbers for crop pollination (Chapter 45).

Part IX. History of bee products
Chapters 46-51

Chapter 46 describes methods developed for handling and processing honey and beeswax. Honey was always a primary bee product, used for food and medicine, and in many societies also for fermenting into an alcoholic drink (Chapters 47, 48). Many peoples had no wax except beeswax, and this had important applications including lighting and the lost-wax process for casting metal (Chapter 49).

Early man must sometimes have consumed other substances removed from bees' nests with honey comb: pollen, royal jelly, propolis and brood. From the 1950s, these substances were collected separately and marketed commercially. Bee venom had been extracted for medical use from the late 1800s (Chapter 51). Stinging bees were used as a weapon of war from Ancient times (Chapter 50).

Part X. Bees in the human mind
Chapters 52-54

Chapter 52 traces the growth of scientific knowledge about honey bees, what they collect and what they produce. Bees had been kept in hives for at least 4500 years before it was known that the large 'ruler bee' in the hive was not male as in human societies, and the discovery in 1586 that the ruler was female and produced all other bees in the hive was assimilated only slowly. Chapter 53 examines the perceptions of gender in bees, and also human gender roles in relation to honey hunting and beekeeping. Finally, Chapter 54 discusses the part played by beliefs about bees, honey and beeswax in some important world religions.

Appendixes

Appendix 1 collects together some little known early records from China, and Appendix 2 lists beekeeping museums in 29 countries which contain historical material.

Further material

Much detailed information is presented in the 52 Tables printed with the text. More than 2000 published and unpublished sources are cited in the book, details of which are given in the Bibliography.

Part I

SETTING THE SCENE

Chapters 2-5

2

The Ancestry of Honey-Storing Insects

All honey-storing insects are social and live in colonies (Section 4.2). They belong to the Aculeate Hymenoptera, and Figure 2.7a shows their relationships; nearly all are bees (Apidae), but a few are wasps (Vespidae) and ants (Formicidae). They collect nectar from flowers and make some of it into honey, and obtain other nutrients from the pollen in flowers; both honey and pollen are stored for future use.

2.1 Evolution of insects that feed on flowering plants

It has generally been considered that flowering plants (angiosperms) appeared during the same period of evolution as insects that feed on them. Table 2.1A (see p. 8) gives a notional chronology of the appearance of honey-storing bees, according to which the first social Hymenoptera evolved in the Cretaceous, and honey bees in the Tertiary. Future fossil finds may lead to changes in details of this chronology.

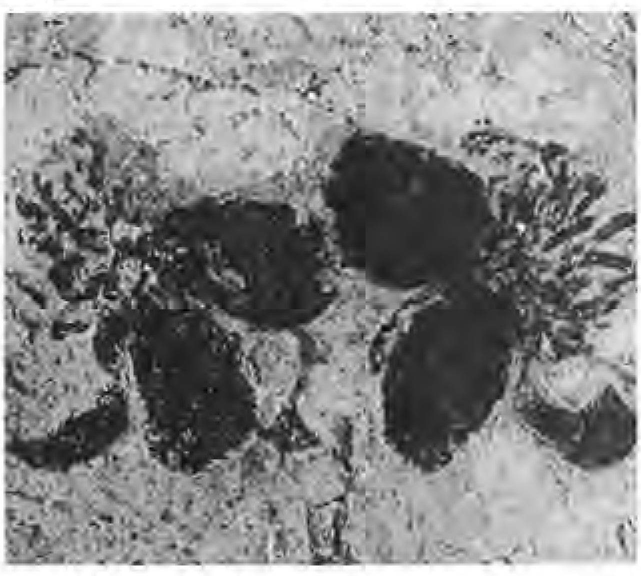


Figure 2.1a Two fossilized flowers, with numerous stamens, of a type foraged and pollinated by insects (Crepet *et al.*, 1974). Found in south-west North America, Middle Eocene in the Tertiary period, about 50 million years ago.

About 100 million years ago, in the Cretaceous, plants that produced flowers became the dominant type, and much of the evolution of their pollinating systems then occurred. Social insects also appeared during this period, and a colony had many foragers which visited the flowers to collect nectar and pollen, and in the process pollinated them. The fossilized flowers in Figure 2.1a are of a type foraged and pollinated by insects, and the fossilized honey bee in Figure 2.3a was dated to about the same period. Poinar (1994) summarized the finds of bees (Apidae) in fossilized resin.

2.2 Evolution of stingless bees (Meliponinae)

The subfamily Meliponinae (stingless bees) is considered first because it is believed to have been the earliest to branch off from less social ancestors and develop highly social behaviour (Winston & Michener, 1977). These bees are confined to tropical regions. In the 1950s a fossil stingless bee from the Miocene – which started perhaps 25 million years ago – was found in Mexico, preserved in solidified tree resin known as amber (Roth, 1958); it is closely related to living species and was named *Trigona (Nogueirapis) silacea*. More recently a fossil female stingless bee was found in amber from coniferous resin 80 million years old, i.e. from the late Cretaceous (Grimaldi, 1988; Michener & Grimaldi, 1988). This bee (Figure 2.2a) is the oldest known specimen of social bees, and its discovery doubles their previously established antiquity. It was named *Trigona prisca*, and it has characteristics known in a living species.

2.3 Evolution of bumble bees (*Bombus*) and honey bees (*Apis*)

Some time after the Meliponinae diverged from other groups of bees and developed a highly social behaviour, the subfamilies Bombinae and Apinae did so, giving rise to the honey-storing bumble bees (*Bom-*

Table 2.1A

Notional chronology of honey-storing bees and of animals exploiting them, except hominids

Millions of years BP	Geological era, period and epoch	Bees and ancestors	Exploiters of honey-storing bees
565			
	Palaeozoic era		
590	Cambrian, Ordovician, Silurian		
	Devonian	first (wingless) insects	first amphibians
360			
	Carboniferous (coal measures)	first winged insects	first reptiles
286			
	Permian	many more insects, including beetles	
248			
	Mesozoic era		
	Triassic		
213			
	Jurassic	first primitive (plant-feeding) Hymenoptera	(or Triassic) first mammals
144			
	Cretaceous	insects feeding on flowers, including ants, wasps, solitary bees, social bees including stingless (Meliponinae)	first birds
65			
	Cenozoic era		
	Tertiary: Palaeocene		
55	Tertiary: Eocene	bumble bees (*Bombus*) honey bees (*Apis*)	primitive primates stylops (Strepsiptera) many families of birds
38			
	Tertiary: Oligocene	at end, *A. dorsata*, *A. florea*	first higher primates first Mustelidae
25			
	Tertiary: Miocene		bears (*Ursus*) fossil shrikes, woodpeckers
5			
	Tertiary: Pliocene	at end, *A. cerana*, *A. mellifera*	further bird diversification chimpanzee (*Pan*) fossil bears (*Ursus*)
2			
	Quaternary: Pleistocene (Ice Ages)		fossil bee-eaters, honeyeaters, humming birds; no fossil honeyguides known (for hominids, see Table 6.1A)
0.01 (10,000 years)			

bus) and honey bees (*Apis*). Some species of both these bees were successful in temperate regions.

Figure 2.3a shows a fossilized honey bee found in 1993, which has greatly extended the known period of the existence of these bees. It was dated to the Middle Eocene, about 50 million years ago, and named *Eckfeldapis electrapoides* (Lutz, 1993). The pollen-collecting apparatus on the hind leg is similar to that of present-day *Apis*, with a corbicula and the characteristic single hair, and a pollen load was in place on one leg.

There have been many discussions as to where and how the *Apis* arose (e.g. Michener, 1974; Koeniger, 1976; Ruttner, 1988), but different species had evolved by the end of the Oligocene in the Tertiary, 25 million years ago. A fossilized piece of honey bee comb found near Kuala Lumpur in Malaysia could be identified, by the size of its cells, as belong-

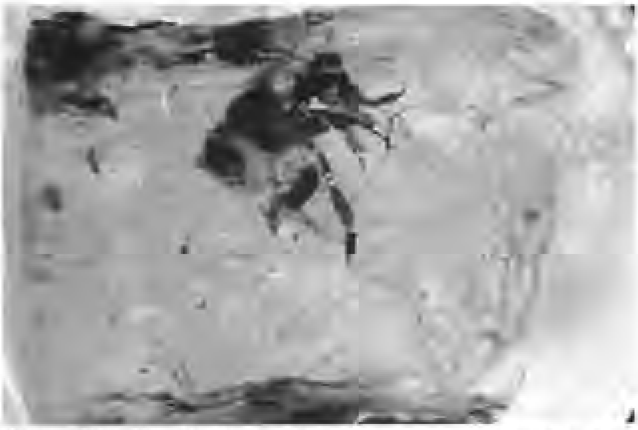


Figure 2.2a Fossil stingless bee, *Trigona prisca*, found in New Jersey amber, late Cretaceous, about 80 million years ago (Grimaldi, 1988).

Figure 2.3a Newly discovered early fossil honey bee from Germany, *Eckfeldapis electrapoides*, Middle Eocene, 50 million years ago (Lutz, 1993).

ing to a nest of *Apis cerana* (Stauffer, 1979). It is considered to be a few million years old, from the late Tertiary or early Quaternary.

If earlier finds of social bees are validated, they might predate the period accepted for the first appearance of flowers.

2.4 Evolution within the honey bees (*Apis*)

The honey bees, which are known from the Eocene, have been and are the most important bees in man's honey hunting and beekeeping. *Apis dorsata* and *A. florea*, which build a single-comb nest in the open, probably branched off first, before the end of the Oligocene. Long after, in the late Pliocene, two highly advanced cavity-nesting species arose, which build a nest containing a number of parallel combs. These are *A. cerana* and *A. mellifera*, which have existed for only perhaps a tenth as long as the open-nesting species, but which extended their distribution into temperate Asia and Europe, respectively: colonies developed the ability to survive a cold winter by forming a cluster within the shelter of the nest cavity.

Subspecies and races of *A. mellifera* are mentioned in later Chapters. They developed during the evolutionary period as a result of geographical isolation caused by barriers of sea, desert and high mountain ranges, and also by barriers caused by changes in climate during the Pleistocene (Ice Age). The final glaciation reached its greatest extent some 10,000 years ago. Each successive extension of the polar ice sheet locked up much water as ice, so the sea level fell, creating land bridges between some continents. Bees and many other animals, including man, could pass across these to new regions as indicated in Table 6.1A. For instance many of the present islands off south-east Asia (Figure 3.4a) were attached to the continental land mass. When the climate became warmer again, much ice melted, and islands were created by the flooding of low-lying land.

Ruttner's 1988 book described the biogeography of these bees, and in D.R. Smith's (1991) a number of specialists presented recent findings.

2.5 Evolution of honey-storing wasps

The earliest wasps (Vespidae) were parasitic, obtaining protein food for their larvae from insects or other arthropods that served as living hosts. But some of the wasps that arose from them collected nectar, and made and stored honey, and also collected pollen which provided protein for the larvae. Table 13.3A lists species from which man collected honey, including *Brachygastra*, *Polybia* and *Protonectarina* in the tribe Polybiini, which live in tropical South and Central America.

2.6 Evolution of honey ants

Ants were some of the first insects to develop a social way of life, and the thousands of species that evolved are all social. The most primitive and earliest known fossil ant *Sphecomyrma freyi* is from the late Cretaceous period 80 million years ago; it was found in the New Jersey amber that yielded the stingless bee shown in Figure 2.2a.

Although many species of ant feed on nectar, honeydew and pollen, they do not secrete any comb-building

material, and most do not make or store honey. But a few species, mostly in the subfamily Formicinae, developed the ability to store honey within the bodies of some of the young workers of the colony known as 'repletes' (Section 3.9).

2.7 Relationships between honey-storing insects

Figure 2.7a shows the family tree of insects that make and store honey. All are in the Order Hymenoptera, in superfamilies Apoidea (bees), Vespoidea (wasps) and Formicoidea (ants). Within the Apoidea, the family Apidae consists of three subfamilies, whose present diversification is related to the duration of their evolutionary period (Table 2.1A). This period was long for Meliponinae and led to the development of 5 genera and over 500 species. It was relatively short for Apinae, and the single genus *Apis* has perhaps 9 species. The period was intermediate for Bombinae, which has a few genera and some 300 species. Within the Vespoidea, the family Vespidae has several genera of honey-storing wasps (Table 13.3A). Within the Formicoidea honey is stored by only a few genera in the family Formicidae (Table 13.4A).

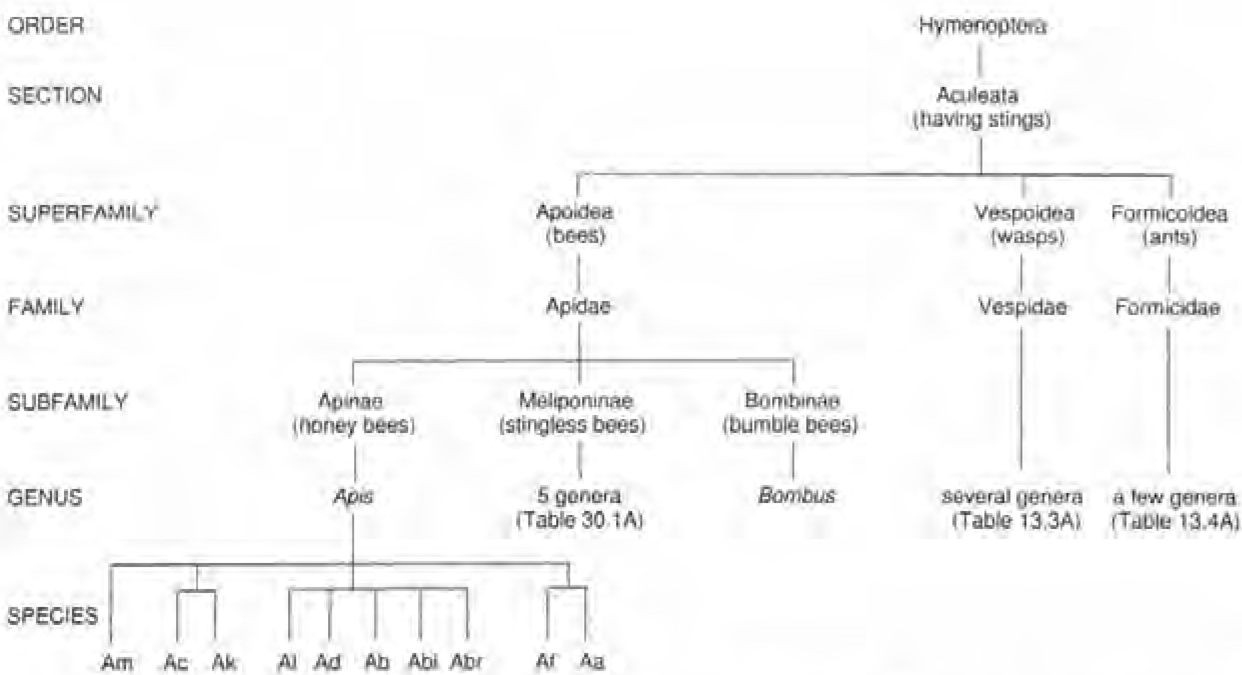


Figure 2.7a Diagram showing the taxonomy of honey bees (*Apis*) and other insects that store honey (based on Crane, 1990a).

Aa *andreniformis*	Ac *cerana*	Al *laboriosa*
Abi *binghami*	Ad *dorsata*	Am *mellifera*
Abr *breviligula*	Af *florea*	Ak *koschevnikovi*

See text for explanation.

3

Honey-Storing Insects and their World Distribution

3.1 Introduction

Table 2.1A shows that social insects from which honey could be harvested were in existence long before man. Table 3.1A indicates the regions of the world within which different species and groups of these insects evolved, i.e. in which they are native. Until around AD 1600 they were confined to these regions, but man has since transported some of them to other regions, marked 'i' in the Table; the journeys themselves are described in Chapter 36. Stingless bees are native in many tropical regions, including those where there are no native honey bees, in the Americas, Australia and the island of New Guinea. Parts of the American tropics have native honey-storing wasps – and honey ants which extend north into Central and even temperate North America, and are also in Australia. In temperate regions there are bumble bees. Sections 3.7 to 3.9 describe special features of these minor groups of honey-storing insects as well as their distributions.

New Zealand and temperate parts of Australia were without any honey-storing insects until honey bees were introduced in the 1800s. The same is true

Table 3.1A

World distribution of bees and other insects from which honey has been harvested

Ac, Ad, Af = honey bees: *Apis cerana, A. dorsata, A. florea*

Am[1] = temperate, *Am*[2] = tropical, *A. mellifera*

Mel = Meliponinae, stingless bees; *Bom* = *Bombus*, bumble bees

n = native; i = introduced by man

Bees whose colonies yield most honey are on the left.

	Ad	*Am*[1]	*Am*[2]	*Ac*	*Af*	*Mel*	*Bom*	*Wasps*	*Ants*
Old World									
Europe, temperate, and all Mediterranean region		n					n		
Africa S of Sahara		i	n		i	n			n
rest of Asia:									
temperate		i		n			n		
subtropical		i		n	n	n			
tropical	n	i		n	n	n			
Other regions									
Americas:									
N temperate		i					n		
N/C, trop., subtrop.		i	i			n			n
S trop., subtrop.		i	i			n	n	n	
S temperate		i					n		
Australia:									
trop., subtrop.		i				n			n
temperate		i					i		
New Zealand, temp.		i					i		
New Guinea (island)		i		i		n			n
Pacific and other volcanic islands		i							one*

* New Caledonia

Figure 3.1a An empty honey bee (*Apis mellifera*) nest in a hollow tree (photographer unknown). A nest of *Apis cerana* in Asia would look rather similar.

for volcanic or coral islands that were formed as new land, unattached to any continent where honey-storing insects evolved, but honey bees were introduced to some of them from the 1600s onwards.

All Old World regions listed in Table 3.1A had one or more species of honey bee (*Apis*) – the most important honey-producing insects. The genus *Apis* diversified into several branches (Figure 2.7a), and the bees of two early branches live in the tropics and build a single-comb nest in the open. These are the very small honey bees *Apis florea* and *A. andreniformis* (Section 3.5), and very large honey bees, especially *A. dorsata* (Section 3.4). A third, later, branch includes *A. cerana* and *A. mellifera*, intermediate in size, which build a multiple-comb nest in a cavity (Figure 3.1a) and can live outside the tropics. Both species penetrated into the north temperate zone in the course of their evolution, in Asia and Europe, respectively, and both separated into a number of subspecies and ecotypes (Sections 3.2, 3.3). Recent research, and views on diversity in the honey bees (*Apis*) by Otis and others, were published in D.R. Smith (1991). Table 52.8A lists species and subspecies/races of *Apis*, and the date when the name now regarded as valid was first used.

Man generally paid most attention to nests of prolific honey producers, but in their absence nests of insects that yielded very little honey were sought out and harvested.

3.2 Distribution of the honey bee *Apis mellifera*

This Section considers both the native distribution and the present extended world distribution of *Apis mellifera*, which has been the most important species to man. It is sometimes called the western honey bee, although it is not native in the Western Hemisphere.

3.21 European and Mediterranean honey bees

Some of these races are the most suited of all to hive beekeeping since they are both productive and amenable to management, and they have been spread worldwide by man. A number of recognized ecotypes evolved and prospered in different climatic regions within Europe, and two were especially valued by beekeepers. The Carniolan bee (*A. m. carnica*) reduces brood rearing during a dearth period, thus conserving food stores that might be needed before the next honey flow. Italian bees, notably *A. m. ligustica* (named after the Ligurian coast near Genoa) store much honey in areas with intense honey flows, although during a summer dearth they may continue to rear brood and therefore to consume stored honey. Many show a yellow or golden colour, which in the eyes of some beekeepers constituted beauty in a honey bee – especially in a queen – although body colour has no direct effect on the performance of bees.

Figure 3.2a shows the native distribution of *Apis mellifera*, which extends from the southern tip of Africa to southern Scandinavia and Russia in the north, and from the Caspian Sea and beyond the Ural mountains in the east to Ireland in the west. (Ireland became separated from Britain while Britain was still part of continental Europe, and the presence of honey bees in Ireland is discussed in Section 9.43.) The spread of the species has been limited in the west and south by oceans, in the north by arctic cold, and in the east by various barriers including mountains and desert.

Many recognized subspecies, races and ecotypes of *A. mellifera* have been described, e.g. by Ruttner (1986, 1988), and they vary slightly in body size, which may be assessed by measuring the width of the worker brood cell between parallel walls; this width varies between 4.6 mm for some African ecotypes and 5.1 to 5.5 mm in northern Europe.

A. mellifera from Europe, and from Africa south of

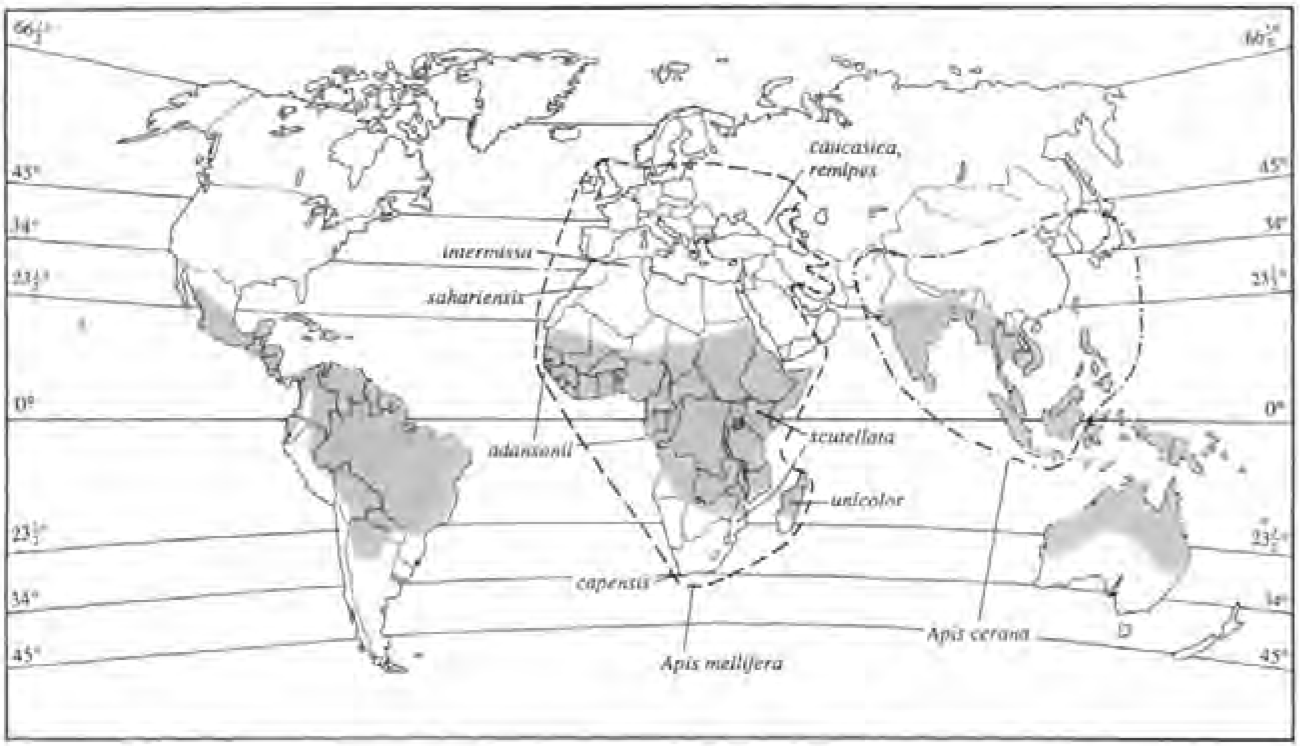


Figure 3.2a Regions where cavity-nesting honey bees, *Apis mellifera* and *A. cerana*, and (shaded) stingless bees, Meliponinae, are native (Crane, 1990a).

the Sahara, became very important to beekeepers in many countries to which they were transported. Settlers who went from Europe to North America from the 1500s onwards introduced many European plants and animals to increase the productivity of their new homelands, and from 1616 these introductions included (dark-coloured) *A. m. mellifera*, mostly from Britain and France (Chapter 36). From the late 1800s onwards other races – especially Italian *A. m. ligustica* – were successfully introduced.

Entries in Table 3.1A show how widely European honey bees were distributed over the world. There was also much mixing of races and ecotypes as a result of transport within Europe, and bees with special characteristics were imported from other continents (Chapter 36); for instance in Anatolia, the high central plateau of Turkey, the bee was the very hardy *A. m. anatoliaca*; between the Sahara and the Atlas mountains to the west of North Africa, it was the frugal and hardy *A. m. sahariensis*.

In general, ecotypes of *Apis mellifera* native to the hot and often rather dry countries to the south and east of the Mediterranean Sea proved less productive than European honey bees, and they were also less amenable to management and more readily alerted to sting. Some of these countries therefore introduced European bees, and encountered successes and difficulties referred to in Chapter 36. Certain Mediterranean races rear a very large number of queens during swarm preparations (end of Section 20.5).

3.22 Tropical African honey bees

Different tropical races of *A. mellifera* evolved in various regions between the Sahara and the Cape of Good Hope. They were described by F.G. Smith (1961a), and races in each region are named in the Sections of Chapter 28. Most races sting more readily than those mentioned above.

Section 36.63 tells the story of the 1956 introduction to Brazil of tropical African honey bees, mostly from low altitudes in South Africa. The bees flourished in the Neotropics, and since 1957 their descendants have spread over much of South and Central America and into North America, ousting the European honey bees descended from earlier importations; see Table 3.1A.

Honey bees native to Madagascar off the east coast of Southern Africa are black *A. m. unicolor*, and these were the first honey bees taken to the Mascarene Islands, Réunion and Mauritius (Secton 36.61).

In the south-west corner of Africa, there is a vestigial population of the Cape bee *A. m. capensis*. Several early records must refer to this bee; the ear-

liest, by Vasco da Gama from Portugal, is mentioned in Section 8.12. In 1778, Carl de Geer's *Insectes du Cap-de-Bonne-Espérance* included a description of the bee, which he named *Apis (fulvo-cincta) nigra*, and a specimen is still preserved in the Swedish Museum of Natural History (Crane, 1980b). Lord de Villiers (1883) and Onions (1912) first described the biology of the bee (Hepburn, 1991, 1995), which has unusual features (see Ruttner, 1988). If a colony becomes queenless, *workers* lay eggs from which the colony can rear a new queen, and she can mate and lay eggs in the usual way. Such a laying worker can also enter a nearby colony of another race and take over as the egg-laying queen. Since 1900 the distribution of the Cape bee has been altered by beekeepers' movements of *capensis* and *scutellata* bees (end of Section 36.61).

3.3 Distribution of *Apis cerana* and *Apis koschevnikovi*

Apis cerana, sometimes called the eastern honey bee although is not the only eastern species, is native in part of Asia (Figure 3.2a). From the western limit in Afghanistan/Iran, its territory reaches to the Pacific Ocean in the east and includes the Philippines, Hainan and Taiwan, and Japan (see below). To the south the natural distribution stretches along Indonesia's island chain as far east as the Wallace Line (Ruttner, 1988); by 1990 it had also become common in parts of Sulawesi (Otis & Hadisoesilo). In the north, *A. cerana* reaches the Primory'e (Far Eastern) Province of Russia, and Japan except Hokkaido in the north. *A. cerana* can live at altitudes up to 2500 m. The width of the worker brood cell varies from 3.6 to 4.0 mm in the Philippines, near the equator, to 4.7-4.8 mm at 30-40°N in Japan; in some high Himalayan regions the width reaches 4.9 mm.

The main subspecies/ecotypes (Ruttner, 1988) are listed below roughly in order of increasing body size.

- *A. c. indica*: Philippines, Bali to Java and Sumatra, Malaysia, Thailand, Sri Lanka, S. India (both 'hill' and 'plains' varieties), Yunnan; see Peng *et al.* (1989).
- *A. c. cerana*: Himalayas (Singh, 1989); Afghanistan, China; Russian Far East (Pesenko *et al.*, 1989).
- *A. c. japonica*: Japan (including Tsushima between Honshu and Korea); see Section 29.32 and a well illustrated account by Okada (1990).
- *A. cerana* in Kashmir: the bees are sufficiently large to be kept in hives with *A. mellifera* comb foundation and comb-spacing.

Where European *A. mellifera* was introduced and thrived – as in parts of China, Japan and Pakistan – the area occupied by *A. cerana* decreased substantially. *A. mellifera* could give good honey yields in agricultural areas where there were sufficient heavy honey flows from crop plants. *A. cerana* was not able to work the flows so intensely, and its area was reduced to hilly uncultivated country where it could survive on the native flowering plants, whereas *A. mellifera* could not. A similar situation occurred in certain parts of the more tropical countries. Man has extended the distribution of *A. cerana* only slightly, and mostly within Asia (Section 36.7).

A rather similar species, *Apis koschevnikovi*, occurs in a small part of south-east Asia including Sabah in Borneo (Tingek *et al.*, 1988; Otis, 1994); compared with *A. cerana* it seems to live at medium elevations. In this book it is not considered separately from *A. cerana*. More recently *Apis nuluensis* in high parts of Sabah, and *Apis nigrocincta* in Sulawesi, have been confirmed as distinct species (*Apidologie* 27(5), 1996).

3.4 Distribution of *Apis dorsata* and closely related species

Apis dorsata, the giant or rock bee, lives only at tropical and adjacent latitudes in Asia. It occurs less widely than *A. cerana*, although it survives at higher altitudes. Its area of distribution (Figure 3.4a) was not much affected by the introduction of European

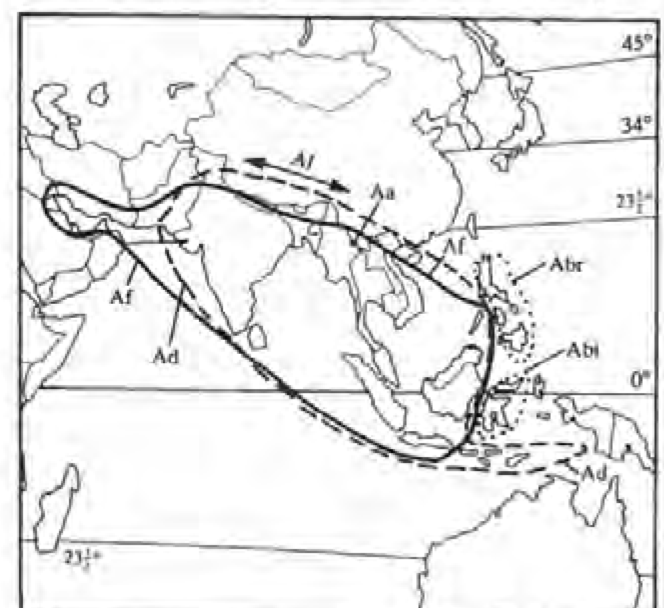


Figure 3.4a Regions where open-nesting honey bees are native (Crane, 1990a). Aa, Abi, Abr, Ad, Af, Al in Figure 2.7a caption.

honey bees, but was reduced by destruction of forests that provided its nest sites and forage, and by human disturbance (Section 10.21, footnote).

A. dorsata occurs across southern Asia, from parts of Pakistan to the eastern end of the Indonesian chain of small islands. The bee is larger, and can fly much further, than *A. cerana*, and thus extended its territory well beyond Bali by flying between islands. In the Philippines and associated islands a rather similar species *A. breviligula* occurs instead of *A. dorsata*, and in Sulawesi the honey bee is *A. binghami* (Otis & Hadisoesilo, 1990). The areas of these three species of large honey bees (Figure 3.4a) are separated by deep-sea channels that had no land bridges even during the Pleistocene.

In parts of the high Himalayan mountain range another separation occurred (Otis, 1994), and an even larger honey bee is present, *A. laboriosa*. Its distribution does not overlap that of *A. dorsata* which rarely nests above 1250 m, whereas *A. laboriosa* may do so up to 3000 m. Underwood (e.g. 1990) studied this bee in detail.

Apart from advances reported in Chapter 18, all honey from these bees was obtained from natural nests (Sections 10.2, 15.2), most of which could be reached only after a hazardous climb.

3.5 Distribution of *Apis florea* and *Apis andreniformis*

Apis florea, whose distribution is also shown in Figure 3.4a, is known as the dwarf or little honey bee. It is native in tropical regions of Asia and as far northwest as Iran, usually at altitudes below 500 m, but in one part of Iran up to 2050 m (Mossadegh, 1993). It has been reported around the Persian Gulf in Iran (Tirgari, 1971) and Iraq, and in the Arabian peninsula: Kuwait, Abu Dhabi, Dubai (K. Khan, 1989) and northern Oman. The extent to which man has aided the extension of the bee's range as far as Oman is not clear, but two recent movements farther west – to Khartoum and Riyadh – must have been made in aircraft (Section 36.7). In part of the Indus basin, and in Oman, people devised a form of beekeeping with this bee (Section 19.2).

The range of *A. florea* is more restricted than that of the larger *A. dorsata* or *A. cerana*. In the east it does not extend beyond Sumatra in the Indonesian island chain, or to the Philippines or Sulawesi.

A. andreniformis, which is rather similar to *A. florea*, occurs in regions that include southern China, parts of Burma, Malaysia, Palawan in the Philippines, Thailand (Wongsiri *et al.*, 1990), and also Indonesia, Laos and Vietnam.

3.6 Distribution and features of stingless bees (Meliponinae)

The main distribution of stingless bees within historical times was described by Kerr and Maule (1964) and is shown in Figure 3.2a. The bees occur in most tropical regions apart from deserts and high mountains; in certain desert areas of North America and Australia there are honey ants instead (Section 3.9). Camargo *et al.* (1988) worked out the dispersal of stingless bees in and around Central America during Cretaceous to Pliocene times, in relation to ecological barriers and land bridges then existing. Schwarz (1948) listed a number of American countries and islands from which various stingless bees were recorded in modern times, and it seems likely that many species are now less widely distributed than when human populations were much smaller. On the other hand new species are identified and named each year, and over 500 are already known and described. Most are in tropical South and Central America – 260 in Brazil alone – and 20 to 40 each in the tropics of Africa, Asia, and Australasia; Sakagami (1982) gave some details. Within historical times certain species may have been transported, for instance into Cuba from Yucatan by sea, or from Venezuela along the intervening chain of islands (Perez Pineiro, 1989). Logs containing colonies could also have floated from one island to another.

The species are grouped into five genera. *Melipona* species are found only in tropical America, and Roubik (1990) discussed why they have not extended their range elsewhere. They tend to have the largest body size, some being as large as *Apis mellifera*, and where they occur they are the species most used by man. *Trigona* is an extensive genus of long-winged bees in tropical parts of all continents. Some are as large as *Melipona*, but the smallest is only 2 mm long. There is a single (African) species of *Meliponula* (similar to *Melipona*) and of *Dactylurina* (similar to *Trigona*). Bees of most genera forage on nectar and pollen, but *Lestrimelitta* in Africa and the Americas is a genus of robber bees which get their food from nests of other bees; they have no corbiculae, and collect a honey-pollen mixture from nests of *Trigona* species. Not all stingless bees depend on food derived from flowers, or indeed plants; Roubik (1982) described some species which feed on flesh.

The Meliponinae are not quite as stingless as the name stingless bee implies, but the sting is greatly

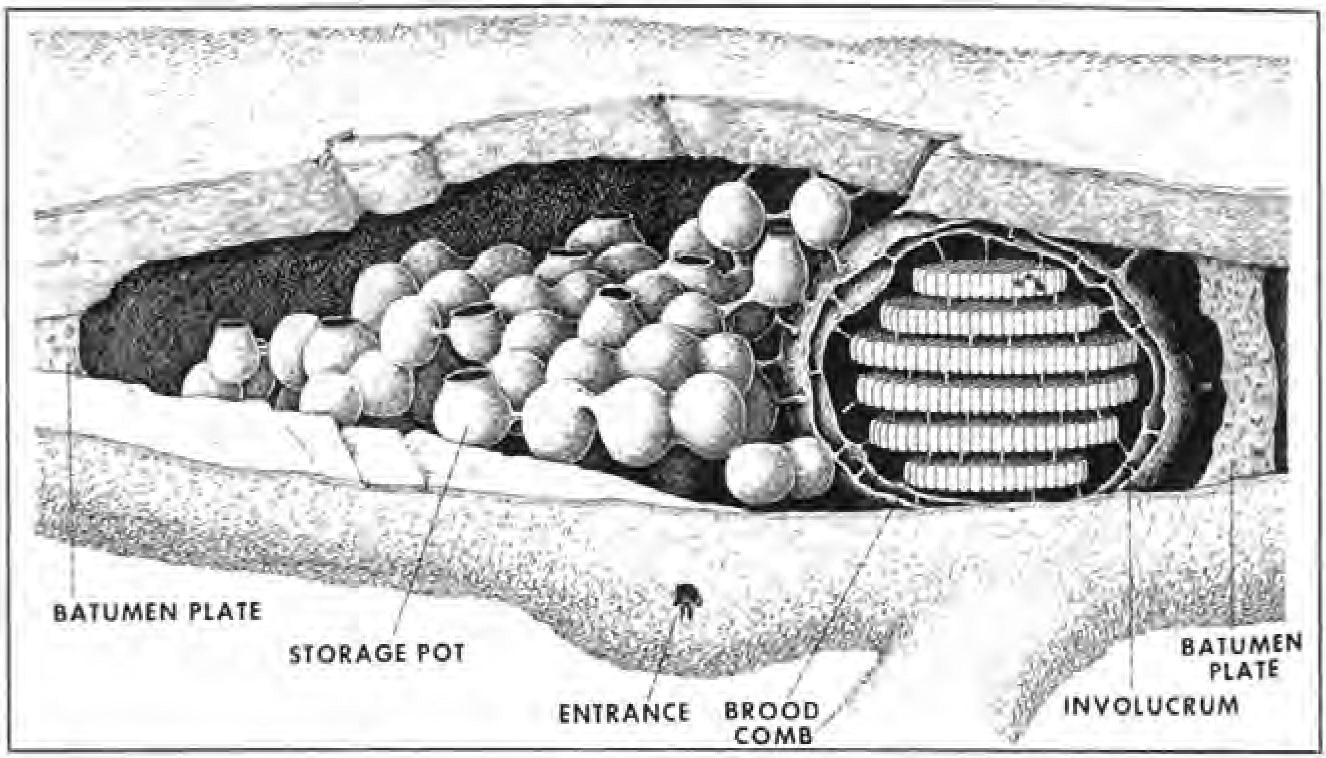


Figure 3.6a Nest of the stingless bee *Melipona interrupta grandis* in a hollow branch (Camargo, 1970).

reduced and without an effective tip, and there is no venom apparatus. The bees' defensive mechanisms against marauders – including man – are biting, ejecting a caustic fluid, and irritating by crawling into eyes, ears, etc.

Except for one species in Ghana, all stingless bees nest in a cavity, often underground or in a tree or termite nest. All species store honey in irregularly built 'honey pots'. Almost all build irregular brood cells as well, but *Melipona* and some *Trigona* make regular horizontal combs for brood. Any area of tropical Africa, Asia, Australasia or America is likely to have species that could be reared in simple hives, and Table 30.1A lists some that have been used in this way.

Stingless bees build most parts of the nest from cerumen (a mixture of wax and propolis), and other parts from wax alone; wax is secreted by the bees, and propolis is a sticky material the bees collect from plants. Much propolis is often incorporated, and 'wax' harvested from stingless bees is regarded as a contaminant of honey bee wax. Figure 3.6a shows one nest, enclosed by a layer of batumen, which is cerumen plus propolis and sometimes also plant materials or mud. Honey and pollen storage 'pots' made of soft cerumen may be separate or intermixed. Many features are common to nests of all species, but the enclosure of brood combs in a separate cavity, as in Figure 3.6a, is not usual.

Figure 11.4b shows an upright nest of a *Melipona* species in a tree cavity, and the Kayapó people in north-east Brazil had names for all 13 features marked.

Reproductive swarming and mating in stingless bees do not proceed in the same way as in honey bees, although the timing is similar – when colonies are populous, and drones are present. The following is likely to be true in general. Before the issue of a swarm, workers from the parent colony rear new queens; they also select a nest site for the swarm and transport wax, propolis and cerumen to it, and start building the nest. They also carry pollen mixed with honey, in their honey sacs. The queen heading the parent colony tolerates the young queens although the workers treat them as queens. The swarm that issues consists of many young workers and one of the young virgin queens, perhaps the one most attractive to them. When it arrives at the new nest a congregation of drones is waiting, and the queen mates – not necessarily in flight. Meanwhile the young workers of the swarm have started to construct brood cells, and the queen starts to lay eggs in them very soon after mating. Details of the swarming process, and variations between species, were described in detail for bees in West Africa by Darchen (1977) and for those in Brazil by Engels and Imperatriz-Fonseca (1990).

Several early explorers in the Americas left records about honey or wax which could have been produced only by stingless bees. For instance when Columbus landed on Cuba on his first voyage to the New World in 1492, he noted 'a variety of honey' among the natural assets of the island; there is a stingless bee in the island, *Melipona beecheii fulvipes* (Schwarz, 1948). The earliest known record of stingless bees in Australia was made by Abel Tasman in 1642 (Section 11.52).

Section 36.81 gives details of the transport of stingless bees around the world.

3.7 Distribution and features of bumble bees (*Bombus* species)

Table 3.1A shows where bumble bees are native and where they have been introduced by man. These bees are able to live in temperate regions of the world by maintaining a colony only until the end of summer. Then the workers, drones and the colony's queen all die, and each newly reared and mated queen hibernates alone through the winter, usually underground, to found a new colony in the spring.

In the Old World bumble bees occur throughout Europe, the Mediterranean region and temperate parts of Asia. They survive without man's intervention at higher latitudes than any other honey-storing bees, even within the Arctic Circle. Books by Alford (1975) and Prys-Jones and Corbet (1987) deal with British species. Bumble bees are native in temperate regions of both North and South America, living as far south as Tierra del Fuego. No bumble bees are native to tropical Africa, Asia or Australasia, or the Pacific islands, but there are a few species in the American tropics which live in colonies throughout the year; those of the largest, *Bombus atratus*, may last two years.

Although bumble bee nests contain little honey, they were harvested by man in some areas (Section 13.2), and colonies were occasionally reared for their honey (Section 17.3). In the 1800s some species were transported to New Zealand to pollinate certain crops (Section 36.82), and they have recently been kept in hives for this purpose in a number of countries (Section 45.61).

3.8 Distribution and features of honey-storing wasps

Some social wasps in the subfamily Polistinae (family Vespidae) store nectar or honey in hexagonal cells

Figure 3.8a Nest of the honey-storing wasp *Brachygastra lecheguana*, about 30 cm high, in Mato Grosso, Brazil (photo: W.D. Hamilton).

of their combs, much as honey bees do. Wasps do not secrete wax, but they mix saliva with plant materials they collect, such as mud, wood pulp, rotten wood and pith, to make a material with which they construct nests in a variety of forms. In temperate zones social wasps live as a colony only during the summer, as bumble bees do, although the exceptional behaviour of *Polistes annularis* is mentioned below.

Table 13.3A lists species of wasps which store honey, and Figure 3.8a shows a nest of one of them. The species live in or near the American tropics, and build long-lived colonies. Some species of *Brachygastra* (formerly *Nectarina*) build large nests and develop large colonies, and a nest of *B. mellifica* may contain tens of thousands of adults.

Most wasp honey is made from nectar, but Evans and Eberhard (1970) recorded the collection

of honeydew by *Polybia scutellaris*, *Pseudopolybia compressa*, *Parachartergus apicalis*, *Stelopolybia pallipes* and *Vespula* spp. They also quoted an observer who watched a colony of *Polybia atra* in Venezuela: 'returning foragers made repeated excited turns among the group of about 50 females usually sitting on the envelope, which incited the nest wasps to activity and flight ... Later Lindauer found that 10 wasps [*P. scutellaris*] visiting a feeding site 150 m from their nest recruited 5 to 7 new foragers to the site in ½ hour.' But there seemed to be no precise communication of the site location as in honey bees.

Deleurance (1952) noticed that in autumn females of *Polistes gallicus* were 'forcibly crammed' with what was referred to as honey. These wasps swallowed and regurgitated throughout the day, probably reducing the water content of the liquid as honey bees do (Crane, 1990a, Fig. 3.36a). In South America *Polistes canadensis*, which builds vertical combs, sometimes nested along rafters of buildings in which sugar cane was processed. A little honey was stored in brood cells, and any honey not consumed by larvae dried to form a hard deposit.

Strassman (1979) drew attention to storage of honey by females of *Polistes annularis* at a site in Texas, USA. They stored it in the nest in autumn and then wintered singly (as bumble bees do), but returned to their nest on warm sunny days to feed on the stored honey, and this improved their performance in the next year. Such honey storage is unlikely to have been substantial enough to attract human exploiters. *Polistes* wasps store some honey even at 47°N in Washington State (Akre, 1989).

General sources of information about social wasps include books by Evans and Eberhard (1970), Wilson (1971), Spradbery (1973), Akre (1982), Ross and Matthews (1991).

3.9 Distribution and features of honey ants

Ants of a few genera in the subfamily Formicinae, and one in the Dolichoderinae, have developed a specialized caste of repletes: workers that store honey in an abnormally distended abdomen, as shown in Figure 3.9a. Repletes hang immobile from the roof of the underground nest, and returning foragers empty their crop contents by feeding them; the honey can be seen through the transparent wall of the replete's abdomen, which may be stretched until it is 10-12 mm across. Observations on honey ants native to widely separated deserts – in Australia and North America – have shown that a worker taps with her feet on a replete's abdomen to stimulate her to regurgitate honey. In arid regions, lack of water could put a colony in danger of death from dehydration, and various experiments show that water is also stored in repletes (see Hölldobler & Wilson, 1990), and is withdrawn from them by other ants of the colony if the nest is at risk from overheating.

Figure 3.9a Replete honey ant, its abdomen distended with honey (drawing: M.I. Ritchie).

Table 13.4A lists species of honey ants in different regions. *Myrmecocystus* lives in dry parts of western Mexico and USA as far north as Washington state, and others in dry parts of the Australasian region.

Snelling (1976) published detailed information about individual species, and distribution maps for them. One species (in South Africa) is native to the Old World, and species of a few widely diverse genera that live in rain forests of the Old World tropics – for instance *Proformica*, *Prenolepis* and *Oligomyrmex* – show an intermediate stage of replete behaviour.

4

Features of Honey Bees in Relation to their Use by Man*

4.1 Introduction

This Chapter gives a very brief summary of the life history of honey bees, and Chapter 52 explains in more detail how the knowledge was accumulated over many centuries. Here, Section 4.3 explains the process by which bees and certain other insects make honey, and 4.4 describes the seasonality of the bees' production and storage of honey. Section 4.5 discusses features of the bees that were especially valued by man during successive stages in his use of them.

Figure 4.2a Single-comb nest of *Apis florea*, with bees removed, Thailand (photo: J. Nakamura). The comb in view shows concentric rings of brood at different stages, with drone cells below. Above, the honey comb – mostly sealed – has been built round the branch that supported the comb. Here the cut ends of the branch are tied on to a triangular rack to display the comb for sale, c. 1990; see Section 10.4. Section 19.21 explains the arrows.

4.2 The honey bee colony and its members

Figure 3.1a shows a natural multicomb honey bee nest in a cavity, and Figures 4.2a and 4.2d show single-comb nests in the open.

The queen is the only reproductive female in a colony; she lays all the eggs, and is the mother of all the other bees. All other females are non-reproductive 'workers', and Figure 4.2b shows a laying queen surrounded by workers that feed and groom her.

Life history of temperate-zone Apis mellifera

Honey bee colonies reproduce by swarming. Towards the end of winter the queen starts to lay eggs and, in spring, brood rearing increases rapidly; in early summer the population becomes high, with many thousands of bees, and the colony is likely to rear

Figure 4.2b *Apis cerana* queen surrounded by a 'retinue' of young workers (photo: I. Okada).

*For use of the word 'man' in this book, see start of Chapter 6.

Figure 4.2c Clustered swarm, *Apis mellifera* (photo: J.G. Tanner)

drones (male bees, see below) and also several queens. When the new queens in their cells are nearly adult, during the warm part of the day a 'prime' swarm issues which contains the original queen heading the colony and about half of the adult workers. The swarm flies to a branch or some other support nearby and clusters there, as in Figure 4.2c. From the cluster, a few workers known as scout bees fly off, and locate and inspect any cavities in the countryside around that might serve as a new nest site. The scout bees can estimate the size of a cavity by walking over its inner surfaces, and are likely to select one whose volume is between 20 and 100 litres. The whole swarm flies to the cavity selected (Section 52.53), builds comb and makes a new nest there. The number of colonies that can survive in any area may be limited by a shortage of nest sites (Section 20.11).

In the colony left in the nest or hive, only one new queen finally survives. When she is a few days old, she flies out and mates with perhaps a dozen drones on a single flight, receiving semen containing enough spermatozoa to fertilize all the female eggs she lays during the rest of her life. Drones are attracted to a nubile queen in flight by the scent of a sex pheromone she produces. The pheromone is the same for all honey bees (*Apis* species), and where more than one species live in the same area, drones and queens of each species usually fly only during a restricted period of the day, when they do not encounter the other species. A drone dies immediately after mating.

The colony in the nest or hive continues, but has suffered a break in brood rearing, and the harvest the honey hunter or beekeeper gets from it will be only perhaps half as great as if there had been no swarm. The timing of the issue of swarms is critical at high latitudes (end of Section 9.5).

The queen starts laying a few days after mating. Workers develop from fertilized eggs and drones from those that are unfertilized. A larva hatches from each egg in 3 days, and after 5 days of being fed (7 for a drone) the 'nurse' bees seal the cell; the larva then spins a cocoon and pupates. The pupa becomes an adult and emerges from the cell after a further period which is about 8, 13 and 15 days for a queen, worker and drone, respectively. Drones, from unfertilized eggs, pass on to the next generation (via the queen they mate with) genetic characters only from their own mother-queen; they are not reproductives in the true sense.

Worker bees carry out the many activities necessary for the colony's survival and well-being. Young workers remain in the nest or hive: they secrete wax and build combs; they keep the nest clean, tend larvae and give them food secreted from hypopharyngeal glands in the head. Young workers also receive the nectar or honeydew that foragers bring into the colony, and make it into honey. When their venom glands are developed, the workers can defend the nest. During the final phase of a worker's life she forages for nectar and pollen. Workers have rather a short life; measurements on temperate-zone *Apis mellifera* show that a worker reared during the summer lives only a month or so. Workers born in autumn may live six months – until after the colony starts to rear brood again next spring. The reason for this difference is explained in Section 52.61.

After emergence from their cells as adults, bees need food containing carbohydrates to supply them with energy: nectar and other sweet plant materials including honeydew, from which they make honey. Young bees also need protein, obtained from pollen, to enable them to produce food for larvae and for the egg-laying queen. Pollen also provides essential minerals, amino acids and vitamins. (Many social wasps and ants are carnivorous, and obtain protein and other nutrients from flesh of live or dead animals, and Section 3.6 refers to unusual stingless bees which do this.) Workers also collect water, and pro-

polis – sticky plant materials used with wax in some building operations.

In winter it is often too cold for the bees to fly; they form a cluster on the combs and cease to rear brood, so they can live at a lower temperature than in summer. When necessary they feed on stored honey. Section 9.5 discusses the northern limit of survival for *A. mellifera* in Europe.

Life history of cavity-nesting honey bees outside Europe

The life history of temperate-zone *A. cerana* in Asia is rather similar to that described above. But the bees are smaller, make smaller colonies and fly less far; they protect their nests more effectively against wasps and hornets, and they do not collect or use propolis. Colonies of temperate-zone *A. cerana*, like those of *A. mellifera*, can survive quite cold winters in sheltered nest cavities. Punchihewa's 1994 book described tropical *A. cerana* and beekeeping with them.

In the tropics, dearth periods occur when plants do not flower because of drought and heat, or excessive rain. However, since temperatures are high enough for bees to fly, tropical ecotypes of *A. mellifera* in Africa and *A. cerana* in Asia were able to develop a survival strategy: all the adult bees of the colony fly away (abscond) to a nearby area where flowers are coming into bloom (Section 4.5).

Life-history of open-nesting honey bees

The very large honey bee *Apis dorsata* and the small honey bee *A. florea* are native only in the tropics of Asia. Their colony structure and behaviour are very similar to those of *A. mellifera* and *A. cerana*, but their nest is a single comb built in the open air (Figures 4.2a, 4.2d). Such a nest is not in a protective enclosure, so workers maintain a curtain of bees permanently round it, to protect the brood and food stores from predators and robbers, and to keep the brood at a sufficiently constant temperature for its proper development. In parts of Nepal, *A. laboriosa* colonies survive through the winter by clustering, without building comb, in sheltered sites below about 2000 m (Underwood, 1990).

The *A. dorsata* comb may be 1 m or even 2 m across, and large amounts of honey are stored in it. The bees are readily alerted to sting, and have a reputation for being very 'fierce'. Up to a hundred or so colonies may build their nests close together where sites are available which are strong enough to carry the weight of the comb and contents, such as high branches of a single large tree. This gregarious nesting also provides extra protection against enemies. There must be a clear air space round and below the nests, as in Figure 4.2d, for reasons explained in Section 10.21.

A. florea is a rather gentle bee which often builds its comb (perhaps 10 cm across) only a few metres from the ground, in a fairly clear space loosely surrounded by vegetation. If the nest is disturbed, the colony often survives by flying to a branch close by, and building a new nest there. If the original comb has not been entirely removed, the bees collect particles of its wax as they would collect pollen, and carry them to incorporate in their new comb (Seeley, via Ruttner, 1988).

4.3 How honey bees make honey

Nectars from different plants contain various proportions of sucrose, fructose and glucose, and the total sugar content is often around 30-40%. Honeys from temperate-zone *Apis mellifera*, which have been most studied, contain about 80% sugar: mainly fructose and glucose but also small amounts of sucrose and some other sugars. In converting nectar into honey, worker bees in the colony evaporate excess water; also, their hypopharyngeal glands secrete the enzyme invertase which inverts most of the sucrose in nectar into fructose and glucose. Fructose is more soluble in water than glucose or sucrose, and as a result of the relative solubilities of the sugars in a solution containing all three – at temperatures in a honey bee colony – an extra total amount of sugar can be held in solution and even more water can be evaporated. The high total sugar concentration in honey is beneficial in that most yeasts cannot ferment in it. Also, together with one other constituent (glucose oxidase), it gives the honey antimicrobial properties, and it can be stored safe from spoilage (Sections 47.1 and 52.44); also, the finished honey occupies less storage space in the nest.

The enzymes invertase and glucose oxidase were found to be present in honeys studied from colonies of various honey-storing insect species: four honey bees, two stingless bees, a bumble bee, a honey wasp and a honey ant. Honey from one of the stingless bees (a *Trigona* species) and a wasp (*Protonectarina*) had rather large amounts of the enzymes, and honey from *Apis dorsata* had rather little (Burgett, in Crane, 1990a).

Figure 4.2d Nests of *Apis dorsata* on main branches of *Koompassia excelsa*, where there is a clear space around them, Malaysia, 1957 (photo: H.T. Pagden).

4.4 The seasonality of honey production, storage and harvesting

In temperate zones, every year a warm or hot summer alternates with a cool or cold winter. After the end of winter, plants start flowering again, and a colony of social insects which feeds from flowers can collect fresh food. Brood rearing increases in the spring and reaches a maximum in early summer. (The colony may meanwhile become so large in relation to the queen's capabilities that it swarms; see Section 4.2.) In spring and early summer, rather little nectar may be converted into honey, because most of it is consumed by the many young non-foraging bees in the colony, and by the whole colony during spells of inclement weather when nectar cannot be collected. After midsummer the rate of brood rearing and the number of young bees decrease, and nectar collected that is surplus to the colony's immediate requirements is made into honey and stored – to be used by the colony in winter.

The supply of nectar is not constant even during the summer. It is available in large quantities only during a 'honey flow', when a great number of individual nectar-yielding flowers are open at the same time. In the course of a summer any one area may have one, two or three major honey flows; each lasts for a few days or up to a few weeks, during which most of a colony's honey is made and stored.

The above relates to temperate zones where the annual climatic cycle is one of heat and cold. In the tropics the annual flowering cycle is largely regulated by the occurrence of rain, and is more complex. The annual cycles of colonies and their honey storage vary with latitude, as exemplified in Figure 4.4a.

Another source of honey is *honeydew*. Certain plant-sucking insects, including coccids (scale insects),

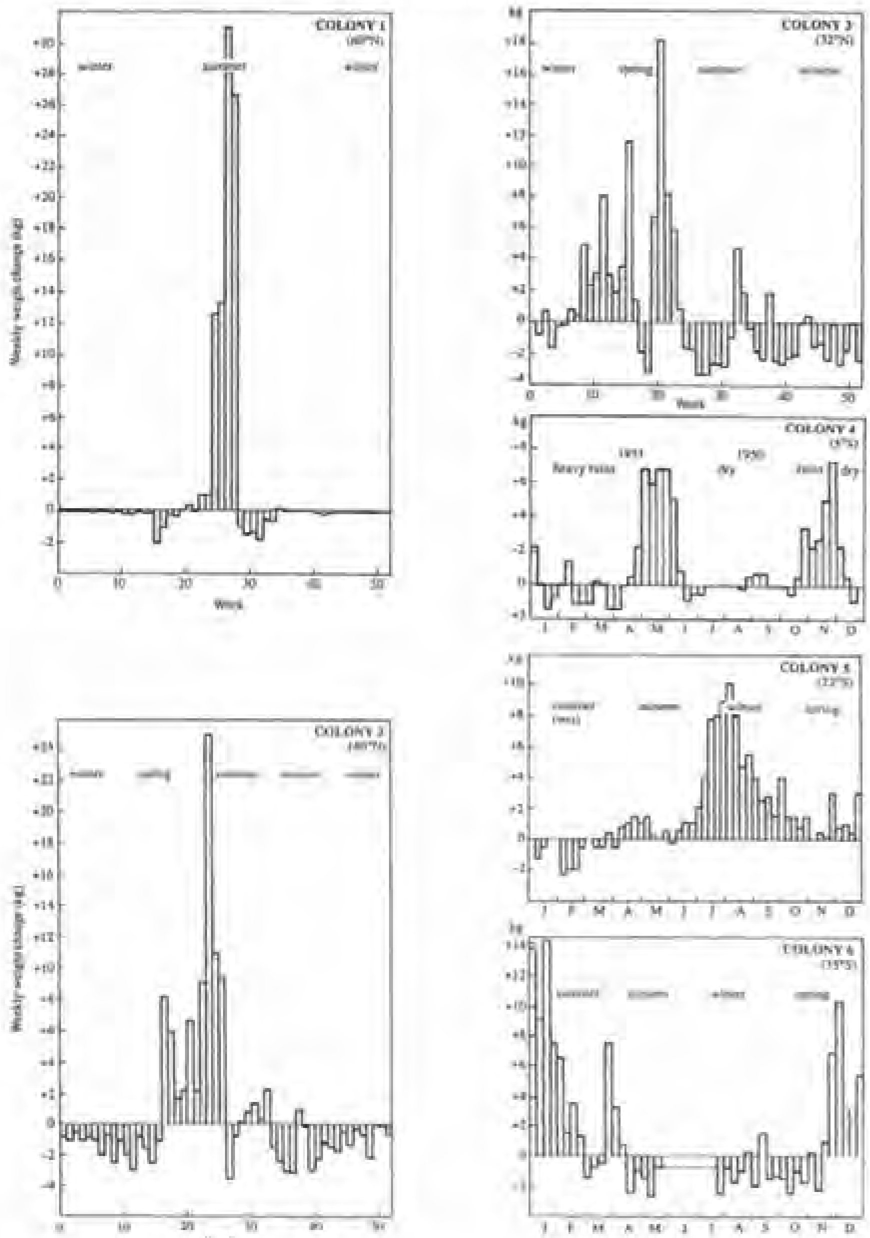


Figure 4.4a Honey storage by colonies of *Apis mellifera* in hives at different latitudes, as indicated by specimen weekly changes in colony weight in kg (Crane, 1990a).

Colony no.	*Latitude*	*Zone*	*Location*
1	60°N	N temperate	Uppsala, Sweden
2	40°N	N temperate	Columbus, Ohio, USA
3	32°N	N subtropical	Tucson, Arizona, USA
4	5°S	S equatorial	Tabora, Tanzania
5	22°S	S tropical	Piracicaba, Brazil
6	35°S	S temperate	La Plata, Argentina

lachnids and aphids, feed directly on the sap of specific plants; they obtain nitrogen from it and also much more sugar than they require. The excess liquid bypasses the midgut where digestion takes place, and is excreted as a sweet liquid called honeydew, which forms into droplets on the plant surface and is collected by bees, wasps and ants. Honeydew 'flows' tend to occur late in the growing season when the insect populations are greatest. Most honeydew is produced on trees; some are deciduous and may also produce nectar and pollen flows, whereas others are conifers and do not.

4.5 Colony characteristics valued by man

Certain genetic characters of bees were important to all peoples who harvested honey, whatever their harvesting technique: opportunistic hunting, owning and tending natural nests, traditional hive beekeeping, or modern 'rational' hive beekeeping. These characters included:

(*a*) good colony survival through dearth periods;
(*b*) good colony survival through an active season in which honey flows were poor;
(*c*) resistance to injury from diseases and pests;
(*d*) storage of much honey in the nest;
(*e*) tolerance of handling, and low tendency to sting when disturbed;
(*f*) bees easily pacified by smoke.

Characteristics of the bees developed in response to environmental conditions during evolutionary times. At high latitudes where winters were long, colony survival was made more likely by (*d*), and where there were specific forage deficiencies due to climate, altitude, soil or other factors, also by (*a*) and (*b*).

Bees' main defence against animal enemies (*c*) is by stinging. In tropical Africa many native mammals, birds and insects obtain food from honey bees or their nests (Chapter 5), and honey bees of the region developed very effective defensive behaviour to protect their nests: the bees are very quickly alerted to sting, and in large numbers. It has been suggested that the stinging propensity of tropical bees was further increased by selection, because honey hunters tended to seek out more docile colonies and avoided those known to be especially 'fierce'.

People who kept colonies in different types of hive wanted bees with somewhat different characteristics. Traditional hive beekeepers who based their operations on the use of swarms wanted bees with a strong tendency to swarm (Section 27.11). On the other hand systems that were developed with movable-frame hives (Section 43.5) required bees with a low tendency to swarm, so that each colony grew very large and produced much honey.

In the temperate zone the main dearths for bees occurred during winters, when it was too cold for them to fly (and for plants to flower). In tropical climates this situation did not arise, and a dearth of flowering plants was usually due to drought, heat, or excessive rain. Honey bees that evolved there could survive a dearth by absconding (the term migration is used for *Apis dorsata*; Crane, 1990a). A colony ceased to rear brood, and scout bees performed dances on the comb surface until all the adults flew off roughly in the direction indicated by the dances, to a nearby area where forage was available during the next few months; these dances did not indicate distance. The same colony might thus provide a harvest for people in the two areas. On the other hand hive beekeepers were left with hives empty for half the year.

Natural nest cavities were normally well separated, but when hives were used and placed close together in an apiary, several previously irrelevant features of the bees became important. Robbing between neighbouring colonies was more likely if hives were close together. Also, bees in colonies near to a hive which a beekeeper had opened might fly out, ready to sting. Flying bees might return to a neighbouring hive instead of their own (drifting), which could result in the transmission of disease or parasites between colonies. Bees tend to drift into colonies at the end of a row, so these grow excessively large at the expense of others, some of which might become weak and die. In several long-established systems of beekeeping, hives were placed close together side by side, and one would expect them to succeed only with bees that had a low tendency to drift. According to El-Banby (1988) this was true of Egyptian bees, and Ruttner (1954) reported similarly on Carniolan bees; both these were kept in close-stacked hives (Figures 20.5b, 35.2d). But experiments on drifting have largely been confined to a single race of bees, and the relative characteristics of different races are not much known.

5

Animals other than Man in Relation to Bees

5.1 Introduction

This Chapter considers mammals and birds which exploited honey-storing bees or their nests before and during man's existence, and were his major competitors for the food in a bees' nest or hive; Table 2.1A lists some important groups. Certain insects – especially wasps and ants – and amphibia also preyed on bees in some parts of the world. In beekeeping books, animals that exploit bees appeared in the guise of bee enemies, and Figures 5.1a and 27.2a show mediaeval European concepts of them; a recent book by Morse and Nowogrodski (1990) discusses them worldwide.

Bees' nests built in the open, by *Apis dorsata* and *A. florea*, may be exploited by flying birds and by mammals that can climb trees. Fewer animals are able to break into nest cavities or hives, but bears and some smaller carnivores can do so, and also birds such as woodpeckers with powerful beaks. Insects and very small mammals, including wasps, ants, and some mice and shrews, might enter some nest cavities through the bees' flight entrance.

Strong day-flying predatory birds and insects can catch bees in flight, and some of these operate near the flight entrance where many bees are present. Certain amphibians also catch live bees at a nest entrance.

Except man, who uses beeswax and propolis, animals exploit bees or their nests only for food. They consume mostly brood (and honey) but may eat adult bees, and honeyguide birds can also digest beeswax. The animals rarely rely on bees for their food throughout the year but, like man, exploit them at the season when the nests contain most food (Figure 5.3b).

Figure 5.1a Mediaeval German woodcut showing honey bee enemies, from a 1502 edition of Virgil's works (Strassburg: Grüninger).

Bee stings: prevention and effects

Starr (1985) suggested that the development of a sting was an important factor in enabling Aculeate (stinging) Hymenoptera to evolve. It allowed individuals to protect their colony against large marauders, with minimal loss to the colony as a whole.

Mammals and birds that obtain food by attacking bees' nests may be protected from being stung round the mouth, by specially adapted fur or feathers or by a tough thick skin that a bee's sting can hardly penetrate. Individuals may learn to behave in a way that minimizes the chance of alerting the bees to sting, or by some other means reduces the chance of being stung (Radford, 1988). But in general an animal's behavioural response to the sudden sharp pain produced by a bee sting does not prevent stinging by further bees.

Animals vary in their sensitivity to bee venom. Species reported to be highly sensitive to stings – probably of temperate-zone *Apis mellifera* – include the dog, horse, goose, chicken, sparrow, macaw, also frog. Species said to be relatively unaffected include rabbit, cat, pig (because of the subcutaneous layer of fat), toad and wax moth (Croft, 1988), but it is not always clear whether the comparison was between the effect of one sting or of 1 mg venom per 1 kg body weight. The toxicity of the venom of different honey bee species also differs. Tested on mice (Benton & Morse, 1968), venoms from *Apis mellifera* and *A. dorsata* were equally toxic, *A. florea* venom less toxic, and *A. cerana* venom twice as toxic.

5.2 Bears

Bears (Ursidae) evolved after the development of honey bees into different species had begun (Table 2.1A), and they are likely to have been an important exploiter of honey-storing bees well before man was present. They are now found from the tropics to beyond the northern extremity of *Apis mellifera*, and the following species search for, and feed on, nests of honey-storing bees (Caron, 1978):

Selenarctos thibetanus, Asiatic black bear, in Asia
Ursus arctos, brown/grizzly bear, in Europe (Figure 5.2a), Asia, North America
Ursus americanus, American black bear, in North America (Figure 5.2c)
Helarctos malayanus, Malayan sun bear, in Asia
Melursus ursinus, sloth, honey, or Indian bear, in Asia.

Figure 5.2a Engraving in a Spanish book of emblems, showing a European brown bear drowning bees before taking their honey combs (Saavedra Fajardo, 1640).

A rudimentary Mesolithic rock painting in eastern Spain – not far from that in Figure 7.3a – shows the leg and foot of an animal, possibly a bear, reaching down towards a hole near which are five flying insects thought to be bees (Jorda Cerda & Alcácer Grau, 1951). Many illustrations of bears as enemies of bees survive from later centuries, and Figures 5.2b and 33.2b show examples. Campbell (1793) reported that bears were 'very destructive to the hives in the interior of North America'.

From what I have seen in different countries, I believe that where bears were present the damage they could do was a main constraint to beekeeping. A belief that a bear would take a hive and hold it under water to kill the bees was illustrated in Spain in 1640 (Figure 5.2a), and some of the beekeepers' devices to kill bears attacking bees' nests were published in Germany in 1774 (Figure 5.2b). Throughout much of Europe and Asia, people went to extraordinary lengths to protect colonies of bees against bears, and to site hives where bears could not reach them. In parts of northern Spain and south-east France remains have recently been found of apiaries on al-

Figure 5.2b Anti-bear devices used by Cheremis and Bashkir tree beekeepers (Krünitz, 1774). One bear, trying to raid a bees' nest (door in tree marked *a*, has released a counterweight and been swung aloft. If the archer hits this bear, it is likely to fall on to the array of spikes below. A second bear is approaching nest *b*, where the trap is set but not yet sprung.

most inaccessible rock ledges, or within by massive stone walls (Section 32.56).

Recent observations include the following. In the hot season in India, the sloth bear is 'on the lookout for the combs of the small forest-bee [*Apis cerana*] in hollow trees, and also for the huge combs of the large rock-bee [*Apis dorsata*], which hang in clusters from the branches of trees or from the undersides of rocks. The latter he knocks down to the ground but the combs of forest-bees ... must be taken the hard way.' Perry (1970), who wrote this description, quoted a long passage by V.K. Arseniev about the behaviour of an Asiatic black bear getting honey in the Manchurian taiga. In north-west Spain the brown

Figure 5.2c American black bear (140 kg) shot on Vancouver Island, BC, Canada (photo: W. Atkins).

bear still does much damage, which Dendaletche (1986) studied in the 1970s-1980s. He found great variations from year to year and from district to district, and suggested that there must be individual 'melliphile' bears which become very skilled in selecting the hives that contain most honey. In Palencia region, around 90% of bear damage in 1978 and 1979 was to hives, but in 1980 there was none – as if the melliphile bear(s) had moved away or died. The American black bear in Figure 5.2c had been shot because it destroyed many hives.

Before eating a comb, a bear sometimes carries it well away from the nest it came from, in an attempt to escape from flying bees. About 1960 in the Peace River area in northern Canada, Corner (1990) watched a black bear carry part of a hive containing honey and brood combs from an apiary into the woods, walking on two legs as a man would.

5.3 Other carnivores

The first Mustelidae (which are also carnivores) evolved before the bears. Though smaller than bears, their very powerful forelegs and claws equip them for exploiting honey bee nests. A strong-smelling secre-

Figure 5.3a Honey badgers or ratels, *Mellivora capensis* (Dunbar, 1840).

tion from the anal scent gland is used for scent-marking, and by some species also for incapacitating bees on honey combs; see below.

One of the most specialized of these carnivores is the honey badger or ratel (*Mellivora capensis*) shown in Figure 5.3a, of which there are 15 subspecies. With increasing human population, it has become nocturnal. It is still fairly widespread in much of Africa south of the Sahara, and is found in Asia from Israel and the Arabian peninsula to Iran and India south of the Himalayas. Kingdon (1977) gave a detailed account of the life and behaviour of the ratel. It feeds preferentially on nests of honey bees when they contain much honey (Figure 5.3b). At other seasons it digs out and may also eat rodents, lizards, snakes and tortoises, according to what is available locally. Ratels probably locate an insect nest by the sound produced in it, and they may blow into a cavity and listen for any reaction. They are also able to find honey bee nests by associating with honeyguide birds

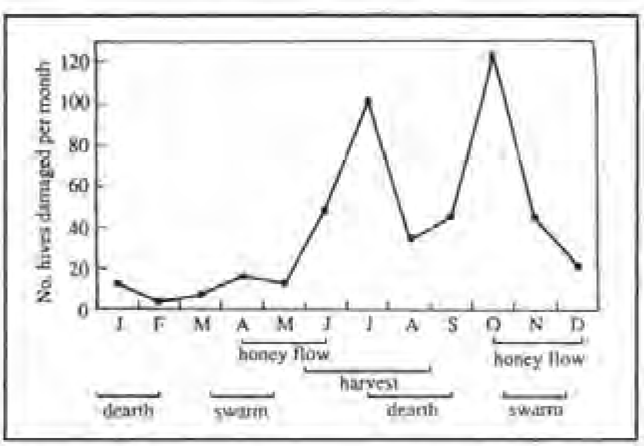


Figure 5.3b Number of hives reported damaged by ratels, in relation to the annual colony cycle, central Tanzania, 1967-1968 (Kingdon, 1977).

(Section 5.5). Gunda (1968) quoted an 1815 report that a ratel could also locate a nest by observing the line of flight of bees returning to it.

Having located a nest and reached it by biting and ripping away the wood protecting it, the ratel destroys it and eats the contents. A cattle herder also told Kingdon (1977) that a ratel 'puts its anus to the entrance hole, swirls its tail, then rubs its anus all around' – distributing an anal secretion which stupefies those bees that have not moved away. Ntenga and Mugongo (1991) referred to a somewhat similar behaviour at hive entrances in Tanzania, and added that ratels dislodged traditional hives fixed up in trees and then fed on combs exposed by the impact of the hive on the ground.

The following are some other Mustelidae recorded as exploiters of honey bee nests; names are from Walker *et al.* (1975).

Old World

Martes flavigula, yellow-throated marten	Nepal, S China to Vietnam
Nycterentes procyonoides, racoon dog, honey dog	Manchuria
Martes foina, stone marten	Europe, Russia
Martes martes, European pine marten	Europe
Meles meles, Old World badger	Europe, Asia
Mustela kathiah, yellow-bellied weasel	sub-Himalayan region to S China
Ictonyx striatus, zorilla, striped polecat	Africa

Americas

Mephitis mephitis, striped skunk	North America
Spilogale putorius, spotted skunk	North America
Eira barbara, tayra	forests of S/C America

In the Carpathians, tracks of the European pine marten in snow were followed by honey hunters searching for trees containing nests of bees (Section 9.31). This was also done in Latvia, where the marten was said to climb a tree 10 paces away from the one containing a nest and jump across to it – presumably so that the bees were less likely to be disturbed (Gunda, 1968).

The woodcut in Figure 5.3c shows a tayra, possibly in French Guiana, trying to get at a bees' nest. 'This beaste seeketh but all partes of this tree for to eate the honey that these flies make ... [It] knoweth the meane to draw out the honey with his pawes, without touching the flyes, nor they him.'

In other animal families, the kinkajou *Potos flavus* (Procyonidae) is a nocturnal racoon-like animal that raids bees' nests in the Central American rain forest.

Other species recorded include armadillo (Dasypodidae) in Brazil, and possibly *Dasypus novemcinctus* and a gamba (a marsupial, *Didelphis* sp.) in South America.

Tigers (*Panthera tigris*) liked to eat brood and honey combs, and in the Ganges delta they broke off *A. dorsata* combs built near the ground (Chakrabarti & Chaudhuri, 1972). They could not reach high combs unaided, but in the Lampung district of Sumatra they frequented the vicinity of trees containing these, and scavenged for pieces of comb that fell to the ground when honey hunters were at work, or when birds attacked the combs (as kites do in southern India). Section 18.1 describes protective measures taken by honey collectors. In Bangladesh, jackals (*Canis aureus*, Canidae) were reputed to knock over hives and take combs (Svensson, 1989).

Figure 5.3c Woodcut from John Parkinson's *Theatrum botanicum* (1640) showing a tayra (*Eira barbara*) digging out a nest of stingless bees in a tree; it is based on André Thevet's picture in 1558.

5.4 Primates

Some primates ate brood and honey from bees' nests. Rhesus monkeys (*Macaca mulatta*) in Asia were seen taking brood from an *Apis florea* nest. In the Ganges delta 'monkeys are said to smear the body with a thick layer of silt before approaching the [*A. dorsata*] combs' (Chakrabarti & Chaudhuri, 1972). In southern Asia various langurs (*Presbytis*) behaved similarly.

In Africa, baboons (*Papio*) are said to break up a hive, or tip it over repeatedly until it comes apart, and then carry the combs away for consumption out of reach of most of the bees. Crane (1975c) quoted a report that they sometimes followed the honeyguide bird, but that monkeys did not. Among the apes (higher primates), Schaller (1965) said that natives of the mountains on the Zaire/Uganda/Rwanda borders told him that 'gorillas frequently raid the nests of wild bees'. Gorillas certainly raid ants' nests. I have found no evidence about gibbons (*Hylobates*, *Symphalangus*) or the orangutan (*Pongo pygmaeus*) in south-east Asia (see Gautier, 1976).

Chimpanzees (Pan spp.)

On an evolutionary basis, the chimpanzee *Pan troglodytes* is nearest to man and is perhaps the most intelligent primate after man (Walker *et al.*, 1975). It lived at the same time as early hominids, but its behaviour can still be studied. According to the Belanda-Biri people in southern Sudan, chimpanzees 'are great honey thieves' (Brown, 1984). They inhabit tropical rain forests of Africa from about 14°N to 10°S, and Deschodt (1969) described an incident in mountains near Lake Kivu, west of Lake Victoria. The sound of screams led him to locate a party of about twenty chimpanzees, a male sitting next to a crevice in a granite wall, and the others below him. The male pulled out brood and honey combs with his hands, took a bite – and got a few stings – then threw the rest down to where the others were waiting. They in turn grabbed the combs and enjoyed them. They were stung, and jumped up and down, screaming, and tried to swat the bees stinging their faces. But all seemed to be enjoying the affair thoroughly, except the babies who snuggled their faces into their mothers' chests.

Van Lawick-Goodall (1971), who made extensive studies of chimpanzees in the Gombe Stream National Park in Tanzania, watched an adult male and his mother co-operating to get honey. They were accompanied by a juvenile sister (and also an infant brother who had rushed up a tree some distance

away). The male pushed a short length of thick stick backwards and forwards in the opening of an underground nest, using it as a lever to enlarge the hole. He waited while his mother reached down with her hand and brought out a honey comb; then he took out some crushed comb and ate it. When the adults left the emptied nest 15 minutes later, the juvenile sister repeatedly put her hand into the hole, each time getting a little honey to eat by licking her fingers.

Chimpanzees farther west also used a stick to get honey from nests. In the Mount Assirik region of Senegal, Bermejo *et al.* (1989) found several sticks 0.6-1.7 m long, all of which had probably been used for the purpose and, more than once, a stick he noticed on the ground was later found stuck into a nest.

In the Mt Kahuze region of Zaire, Yamagiwa *et al.* (1988) found two sticks near a disturbed underground nest of stingless bees named as *Meliplebeia tanganyikae* aff. *nigrita*. Most of its contents had been eaten, and they presented reasons for supposing that the sticks had been used for digging out the nest. Brewer and McGrew (1990) described in detail a very sophisticated use of tools by Katie, a female chimpanzee 11 years old, to get honey from a nest of *Trigona* (*Hypotrigona*) *ruspolii* in a dead stump of a tree branch, on an island in the Gambia River. Having failed to reach the nest by pushing into the flight entrance a flexible 'dip-stick' made from a green branch, Katie forced another entrance by using two thicker branches in turn as chisels. Then, with another branch made into a sharp 'bodkin', she managed to pierce the involucrum of the nest. Finally she made a long flexible dip-stick from a green vine, and applied it to the new hole for about 10 minutes, extracting 'copious amounts of dripping honey'. A series of action photographs showed Katie apparently holding each tool in an appropriate hand grip. Her honey collection, like others described above, was a social affair. Two other chimpanzees waited and watched before succeeding her at the hole into the nest, while another two sat below the tree, collecting and sucking the discarded tools. Some human honey hunters made use of a long thin dip-stick to get honey from inaccessible nests of stingless bees, and upon occasion converted its end into a kind of brush to pick up more honey (Section 11.52).

Fay and Carroll (1994) gave a detailed description of the selection and use of another type of tool in the Central African Republic. A chimpanzee picked up a thick dead piece of branch (30-40 cm long, 10 cm in diameter) and used it to batter a nest of *Trigona* (*Hypotrigona*) *gribodoi* attached to a large tree branch.

The pygmy chimpanzee *Pan paniscus* also uses tools, but I do not know whether for getting honey.

5.5 Birds

Most birds that raid bees' nests are probably seeking brood, or possibly pollen.* The honey buzzard *Pernis apivorus* digs out bees' nests from cavities, and is protected on the face with small close-fitting feathers (see Crane, 1975c); the oriental paraspecies *P. ptilorhynchus* almost certainly has a similar adaptation. In winter, when insect food is scarce, woodpeckers (*Picus*) use their strong sharp-pointed beak to gain access to a bees' nest, and extract the prey with their very long sticky tongue. Figure 5.5a shows an early picture of one at work.

Honeyguides, which feed on the contents of bees' nests, are very unusual birds, in that they eat and can digest beeswax – by means of a micrococcus and a yeast in the gut (Friedmann, 1955; Friedmann & Kern, 1956). In 1569, João dos Santos – a Portuguese missionary working in Ethiopia – remarked on the predilection of the honeyguide for beeswax: he noticed that the bird would fly into a church and eat wax from altar candles (Gunda, 1968). Honeyguides originated in Ethiopia and, like cuckoos, are brood-parasitic birds; their hosts are barbets. In Africa there are 11 species, whose behaviour was studied by Short and Horne (1985). Two or three species, especially the greater honeyguide, *Indicator indicator*, developed a special relationship with a relatively large mammal that could make a bees' nest accessible also to the bird: in the past it was the ratel, and more recently man. Section 8.3 describes the 'guiding behaviour' (Friedmann, 1955; Short, 1986) in relation to man's honey hunting. This behaviour ceases when the bird sees or hears bees: the mammal is then likely to locate the nest and break into it to take the combs, and the bird also feeds – taking adult bees, and comb containing brood, pollen and honey.

Asiatic honeyguides are *I. archipelagicus* in the south-east, and *I. xanthonotus* in the Himalayas and other mountains. Neither is known to 'guide' mammals, but *I. xanthonotus* has another unusual behaviour. The male establishes and defends a territory that includes one or more occupied nests of *Apis dorsata*,† which provide it with a continuous source of beeswax (Cronin & Sherman, 1976). In a forested canyon in east Nepal where the bees nested on a

*Honey-eaters take nectar directly from flowers, as humming birds do.

†A later study by B.A. Underwood (*J. Bombay Nat. Hist. Soc.* 89 (3): 290-5, 1992) showed that this bird associates with *A. laboriosa* rather than *A. dorsata*.

Figure 5.5a Woodcut showing woodpecker at a tree beekeeper's door, and brown bear below (reproduced by Sirera, 1953).

sheer rock cliff, the birds ate the comb where it was attached to the cliff face, apparently having little or no interaction with the bees. During the birds' non-breeding season, a male would allow his female mate(s) and their progeny to eat wax from his *A. dorsata* combs. Friedmann (1955) and Kellogg (1968) quoted a passage written by Chang Hwa between AD 265 and 290:

> After the bees have left the place [cliff face where *A. dorsata* nested, Section 15.22], some of the wax still sticks to the face of the cliff. A kind of bird, the size of a sparrow, comes in flocks to clean the place by picking up the remaining wax. They are called 'spiritual birds'.

Many predatory birds that capture individual insects on the wing prey on bees. The best known are bee-eaters (*Merops*, Meropidae), of which there are 21 species in warmer parts of the Old World and Australasia, described in detail by Fry (1984). The bird shown flying at an *A. dorsata* nest in Figure 10.2e is probably a bee-eater. The birds prey on a wide variety of insects, but if a beekeeper concentrated many colonies of honey bees together in an apiary, these would present bee-eaters with a rich source of flying bees such as was unknown in evolutionary times.

Honey bees generally respond to attacks of bee-eaters by remaining in their nest or hive, although *Apis cerana* bees are sometimes able to escape capture because they can turn quickly, and fly into vegetation. When a bee-eater catches a bee or other stinging insect, it rubs the insect's abdomen against a perch in such a way that the venom is ejected (Fry, 1984); this is presumably a learned behaviour, which is shown also by some shrikes (Laniidae), and in tropical America by jacamars (Galbulidae).

The above birds must have benefited greatly when apiary beekeeping started in their area. So did birds that prey on bees in flight, which include some swifts (Apodidae), especially the Philippine spine-tailed swift (*Hirondus celebensis* = *Chaetura gigantea dubia*), some flycatchers (Muscicapidae) and drongos (Dicruridae) in the Old World, and kingbirds (Tyrannidae) in the Americas. Fry (1983) suggested that such birds must be relatively immune to bee venom, and Morse and Laigo (1969) found many stings in both the mouth and stomach of dissected Philippine swifts – but they were of no apparent consequence to the birds.

Part II

OPPORTUNISTIC HONEY HUNTING BY MAN

Chapters 6-13

6

Man's First Interactions with Bees and Honey

6.1 Early man, and the bees he encountered

For ease of reading, here and elsewhere in the book, the word 'man' is often used in place of the more literal 'human being' or 'humankind'. In this context, 'he', 'him' and 'his' also encompass 'she', 'her' and 'hers'.

Table 6.1A shows the extent to which early hominids had access to nests of various honey-storing bees, although many of the dates quoted are still the subject of discussion in the light of the most recent finds. During the Pliocene, when honey-storing bees had already existed for perhaps a hundred million years (Table 2.1A), early hominids lived in tropical Africa, and fossils of them have been dated to 4 million years ago. Later, species of *Australopithecus* developed in Africa, but the whole genus died out some time during the Pleistocene. Meanwhile another branch of hominids appeared: *Homo*, the direct ancestors of modern man. The first was *H. habilis*, perhaps about 2.5 million years ago (Table 6.1A), who had the same sources of honey and who made

Table 6.1A

Notional chronology of early man's ancestry, development and spread over the earth, and his interactions with honey-storing bees

See Table 2.1A for the period before 10,000 years ago.

1000s of years BP	*Development and spread*	*The bees, and man's probable interactions with them*
		stingless bees (Meliponinae) honey bees (*Apis*)
5000		
Pliocene	*Ardipithecus* and *Australopithecus* in Africa	hunted nests of honey bees (*Apis mellifera*), also stingless bees in the tropics
	Homo habilis in Africa	as above
2000		
Pleistocene	*Homo erectus*:	
	in Africa	hunted nests of *A. mellifera*, and stingless bees (tropics)
	also in Asia	hunted nests of *A. dorsata*, *A. cerana*, *A. florea*, and stingless bees (tropics)
	also in Europe	hunted nests of *A. mellifera* (temperate-zone)
	Homo sapiens	as above
	(Palaeolithic began)	
250		
	H. sapiens neanderthalensis, Neanderthal man, in Europe, Asia	as *H. sapiens*
	H. sapiens sapiens in Africa, Europe, Asia	as *H. sapiens*
	– whence spread to Australia	honey bees absent; hunted nests of stingless bees (tropics)
	– and to Americas	as in Australia
20		
	earliest known rock art in SW France	no known depictions of bees or honey hunting
10		
Holocene (to present)	(final glaciation retreating)	
	(Mesolithic in Europe)	earliest known rock paintings of honey hunting (Europe, Asia)

and used tools. Then came *H. erectus* about 1.7 million years ago, whose fossils have been found in Europe and Asia as well as Africa.*

Colonies of a 'temperate-zone' type of *Apis mellifera* which survived cold winters were living in Europe by the time *H. erectus* arrived there. In Asia, remains of *H. erectus* have been found in widely separated sites: in Java (the first finds), northern China and Japan. Within *Homo sapiens*, two subspecies have been recognized: *H. s. neanderthalensis* (Neanderthal man), and *H. s. sapiens* (modern man). Neanderthal man is known only from Europe and western Asia. In tropical regions, including Java, there were three honey bee species: *Apis dorsata*, *A. cerana* and *A. florea*; in northern China and Japan ecotypes of *A. cerana* survived cold winters.

Morris (1967) suggested that man's great love of sweetness in foods is derived from primates' general consumption of fruits, whose ripeness and suitability for eating were indicated by sweetness. Naim and Kare (1982) found evidence of an innate liking for sweetness: in their experiments, newborn infants consistently chose to drink more of a sugar solution than of water alone.

For the first 99% of their existence, *Homo sapiens* peoples were hunter-gatherers† living in the culture of the Old Stone Age (Palaeolithic). They obtained food by hunting animals (mammals, birds, fish, insects) and collecting plants and their seeds and fruits. Bees' nests were usually sought, and honey combs collected, by men on hunting trips. Several later Chapters describe methods of honey harvesting by some of the hunter-gatherer peoples who have survived to recent times. Women did most of the general food gathering, near where they lived or camped, and Section 53.2 explores the small part they also played in honey hunting.

Man and honey-storing bees in new continents

Man (*H. s. sapiens*) was at first confined to the Old World – Africa, Europe and Asia, where most regions had at least one species of honey bee (*Apis*). However, periods of a warm world climate alternated with cold periods during which additional water froze at the earth's poles; this lowered the sea level, with the result that land was exposed where some shallow seas had been, and individuals in Asia were able to reach new lands. The sea level rose again when the next warm period melted some of this polar ice.

Around 50,000 years ago or even earlier, people from south-east Asia succeeded in 'island-hopping' to the land mass that included present New Guinea, mainland Australia and Tasmania. The travellers had to cross sea channels over 100 km wide, including the deep Macassar Strait where the Wallace Line runs, but some managed to do so. Their descendants reached as far as southern Australia and Tasmania over 30,000 years ago, and descendants of these people were later referred to as Aborigines. In parts of Australia, Aborigines found stingless bees (Section 3.6) and used their honey and wax (Section 11.51). In dry areas there were honey ants instead (Section 3.9).

Some time later, the sea level dropped sufficiently for – probably quite small – groups of people to cross from the north-east of Asia to North America, which were later separated again by the Bering Strait. It is not known when the cold period occurred which allowed the first crossing, but a date about 30,000 BC is commonly suggested. Once in America, the people could move south along an ice-free corridor east of the Rocky Mountains. Their descendants might have encountered bumble bees in North America, but would not have found permanent nests of honey-storing bees until they reached the tropics where there were stingless bees (Meliponinae), perhaps between 15 and 10 thousand years ago. These bees now occur approximately from the present USA-Mexico border in the north to the Bolivia-Argentina border in the south (Figure 3.2a). Within most of this large region, early man could harvest honey from them, and also wax which was essential to some of his later descendants for gold casting (Section 49.46).

6.2 Evidence from rock art

The earliest known representations of bees and their nests are in rock art which is also discussed in Sections 7.1, 8.11, 8.6, 10.22 and 11.51, and a further example is shown in Figure 53.2a. Early knowledge about bees is dealt with in Chapter 52, and early beliefs about them in Section 54.1.

Extent and dates of rock art showing bee-related subjects

Man's earliest representations of animals date from the later part of the Palaeolithic period in southern

*Examination of bone from a very early *Homo erectus* in Kenya (c. 1.6 million years ago) indicated that the individual suffered from hypervitaminosis. Skinner (1991) proposed that the living conditions could have been such that the disorder was caused by excessive consumption of *Apis mellifera* brood, but this proposal was later withdrawn (Skinner *et al.*, 1995) as having been based on an invalid determination of vitamin A in bee brood.

† In this book the alternative term 'foragers' is avoided, because it is commonly used for bees collecting nectar or pollen.

France and northern Spain, where many paintings and engravings have been found in caves and on walls of rock ledges. Paintings in caves at Lascaux in France and Altamira in Spain date from perhaps around 15,000 and 13,500 BC, respectively. Most animals depicted are mammals, and paintings of bears at Ekain (Guipuzcoa) in northern Spain have been dated to between 15,000 and 10,000 BC. Birds and fish also occur, but very few insects or plants. The only suggestion I know of Palaeolithic paintings which might possibly be connected with honey hunting refers to Altamira. On the walls of a side chamber there are patterns of multiple ladders, and on the ceiling four parallel shapes in a pattern similar to some of the 'formlings' in Figure 6.2a(E) which are believed to represent bees' combs viewed from below (Section 8.11). Over the entrance to this side chamber is 'an extraordinary, global stalactite' whose shape Pager (1976) likened to a clustered swarm of bees.

Splendid examples of Mesolithic rock art relating to bees are known in Spain and India, but most examples are later and undated, in Southern Africa.

Register of the rock art

A 'Register of rock art relating to bees and honey hunting' set up in 1985 (Crane, 1986) included records of 118 likely sites in 18 countries by 1997. The majority, in Southern Africa, are discussed in Section 8.11 together with 163 further sites in Zimbabwe that show 'formlings'. Probably more than twice this number are known but not yet recorded in the Register (Genge, 1994). In the Mediterranean region, 14 sites are in Spain, and 1 each in Algeria and Morocco; the bee throughout Europe and Africa is *Apis mellifera*. Representations in Asia show *A. dorsata* nests, with paintings at 12 sites in India and 2 in Sri Lanka; a site in Bhutan at about 2500 m shows engraved nests, perhaps of *A. laboriosa* (Section 3.4). Three sites in Namibia have engravings, but most sites have paintings. In Australia 5 paintings of stingless bees' nests are known. There are no records from the Americas.

Subjects depicted

The following rock paintings, most of which are reproduced in this book, show a honey hunter at a bees' nest.

	Register no.	*Figure*
Europe (Spain)	AI-01	6.2a(C), 7.1a
	AI-02	7.1b
Africa (KwaZulu Natal)	SN-01	6.2a(A)
Africa (Zimbabwe)	ZW-001	6.2(D), 8.6a
	ZN-005	53.2a
Asia (India)	AN-03	6.2a(B), 10.2d
	AN-08	10.2b
	AN-09	–
	AN-10	–
	AN-11	10.2c
Asia (Bhutan)	AV-01	–
Australia (Queensland)	AU-04	6.2a(F)

Table 6.2A summarizes subjects relating to bees portrayed in rock art, group b refers to bees, and group m to man. In Figure 6.2a, A to G show seven representative examples. B is painted in white; three single-comb nests of *A. dorsata* hang from tree branches, and each has a segment painted solid that probably indicates stored honey; Figures 10.2a and 10.2b show other such nests. Flying creatures in a crowd but not associated with a bees' nest (b5) could be bees, although in Asia the species might be in question; or they might be other insects, or a flock of birds. Writers on rock art often refer to bees in large numbers as a swarm, and the bees in Botha's Shelter (Figure 6.2b) have the appearance of a swarm about to settle. But the word is often used loosely, and most 'swarms' look more like bees from a disturbed colony than a cohesive swarm flying with its queen. I know of no certain depiction in rock art of a clustered swarm, shown in Figure 4.2c, but the stalactite referred to above might have symbolized one. However, a swarm has no combs, and yields no honey.

How subjects were represented, and how they have been interpreted

Mesolithic and post-Mesolithic rock art in India showed individual bees as dots or blobs, but some Mesolithic examples in Spain (for instance Figures 6.2a(C), also 7.1a and 7.1b) gave an indication of body shape, and a number of later San paintings in Southern Africa portrayed flying bees very realistically; see Figure 6.2b. The shape of the combs is clear in Mesolithic and later Indian paintings (*Apis dorsata*), and in later San paintings (*A. mellifera*). No paintings of honey bee nests (*Apis*) are known which show realistic cells of the comb, or brood in them, but several Aboriginal rock paintings of nests of stingless bees gave some indication of nest structure, as in Figure 11.5a.

In Table 6.2A, a man is regarded as a honey hunter (m1) if he appears in association with a notional bees' nest – sometimes an actual depression or hole in the

Figure 6.2a Drawings of representative rock art relating to bees and honey hunting (see Table 6.2A); not to the same scale. Most show *A. mellifera* nests.

A Eland Cave, KwaZulu Natal (Register SN-01, Pager, 1973).
B *A. dorsata*: Rajat Prapat, central India (Register AN-03, Mathpal, 1984); also in Figure 10.2d.
C La Araña Shelter, Valencia, Spain (Register AI-01, drawing by Hernández-Pacheco); also in Figure 7.1a.
D Shelter, Toghwana Dam, Zimbabwe (Register ZW-001, copy by H. Pager, 1973); also in Figure 8.6a.
E 'formlings', Zimbabwe (Pager, 1973); see also Section 8.11.
F stingless bees: Coamey Creek, Qld, Australia, found and photographed by P. Trezise (Register AU-04, sketch by I. Ritchie)
G Botha's Shelter, KwaZulu Natal (Register SN-14, copy by H. Pager, 1971); also in Figure 8.1a.

Table 6.2A

Subjects portrayed in rock art that relate to bees and honey hunting, from the Mesolithic period and later

No rock art is known relating to *A. florea*.

			Apis mellifera		A. dorsata	*Meliponinae*
		Figure 6.2a	*Africa*	*Europe*	*India*	*Australia*
b BEES						
b1	Structure of bees' nest with combs	B,D,G	x		x	x (cells)
b2	Formlings	E	x			
	A number of bees:					
b3	in nest	B	x		x	x
b4	near nest	A,B,C,D	x	x	x	x
b5	not near a nest		x			
m MAN						
m1	Honey hunter(s)	A,B,C,D,F	x	x	x	x
	Equipment:					
m2	honey container	A?,B,C	x	x	x	
m3	ladder(s), ropes, lianas	A,B,C	x	x	x	
m4	bundle of smoking grass	D	x		x	
m5	pronged rod				x	
m6	stick for piercing honey pots	F				x
Figures in later Chapters that show rock art:			8.1a	7.1a	10.2a	11.5a
			8.1b	7.1b	10.2b	49.5a
			8.1d		10.2c	
			8.6a		10.2d	
			53.2a			

Figure 6.2b Swarm of bees, Botha's Shelter, Ndedema, KwaZulu Natal (Register SN-14, Pager, 1971).

rock surface (see Section 7.1) – and is carrying a suitable container (m2) or a smoker (m4) or other implement, or with a ladder or rope (m3). In tropical Asia, rock paintings of honey collection from *Apis dorsata* nests may show a long pronged rod (m5), and such a tool is still used in some Himalayan regions for breaking off pieces of comb from a distance (Figure 10.2b). For stingless bees, one honey hunter in Australia is shown holding a short stick (m6), used to break into cells and drain the honey (Figure 6.2a,F).

Ladders, ropes or lianas (m3) are present in many rock paintings, and unless they are shown leading to bees' nests, they could be connected with the gathering of fruit, birds' eggs, or other food.

Interpretation of rock paintings which show the combs of a nest of *A. mellifera* viewed from *below* has a chequered history. In Figure 6.2a(D) the combs are viewed from below although the man smoking the nest to drive out the bees is viewed from the side; such a shift in perspective is not unusual in early art. Comparison of some of the drawings in Figure 6.2a(E) with the photograph of combs viewed from below (Figure 6.2c) suggests that the drawings may also represent the view of multiple combs of a nest from below. These have been referred to as 'formlings' and are discussed further in Section 8.11.

Use of beeswax as a painting medium in Palaeolithic rock art

A few sites are known in Australia where Aborigines used beeswax to make paintings of humans and animals (not bees), and Nelson *et al.* (1995) obtained radiocarbon dates between 2000 BC and AD 1900 for the beeswax used at 8 of the sites in northern Australia. Figure 49.5a shows an example.

Figure 6.2c Nest of *Apis mellifera* at the entrance to a rock cavity viewed from below, Arizona, USA (photo: G.M. Loper).

6.3 Other early representations of bees

Artefacts discussed here were found in or near the Mediterranean region. Those from Egypt follow a 3000-year sequence ending at 30 BC, and some elsewhere are dated before 3000 BC.

Many remarkable paintings on plaster walls were found in a complex Neolithic shrine at Çatal Hüyük in Anatolia, dated to around 7000 BC. Mellaart (1967; also 1963) described the one shown in Figure 6.3a as 'a cellular structure in red ... In the central portion white circles, sometimes with a central dot, fill the cells, and most of those on the right are filled with a flower-like pattern, parallel wavy lines, winged or wingless insects ... The interpretation suggested was that of the life-cycle of the bee in a honeycomb with closed cells on the left, from which, in the middle, the bees emerge to fly freely in a field of flowers on the right.' Such an early representation of immature bees within closed cells would be astonishing, although in Egypt there are many representations of *adult* bees from 3000 BC onwards, which are discussed below. Mellaart *et al.* (1989) published drawings of two other paintings at Çatal Hüyük dated to *c.* 6540 BC, which include flying insects that might be bees – forming a sort of halo round the head of a goddess (VIA.shrine E.VIA.34). In an unpublished drawing of a painting dated to *c.* 6300 BC, similar insects fly around and above a stylized oval shape (Level II, Building A.II.1; *c.* 6300 BC; Mellaart, 1990). Symbolic bull heads were also found in a shrine at Çatal Hüyük.

Individual adult bees are shown in early portable art, and Ransome (1937) reproduced many examples. Gimbutas (1974) published Neolithic representations of 'bee goddesses' from Europe; the earliest are:

- *c.* 6000 BC, on a painted Proto-Sesklo vase from Otzaki, Thessaly.
- 6000-5000 BC, in a relief on a shard from Kopancs, SE Hungary.
- 6000-5000 BC in a Classical Cucuteni pottery relief from Trusesti, W. Ukraine.

Figure 6.3b shows an example from Ukraine dated to 4000-3500 BC.

Figure 6.3a Painting at Çatal Hüyük, Anatolia, c. 6600 BC, suggested as representing honey bees' comb containing brood; east wall of shrine VI B.8, level VI B (photo: J. Mellaart).

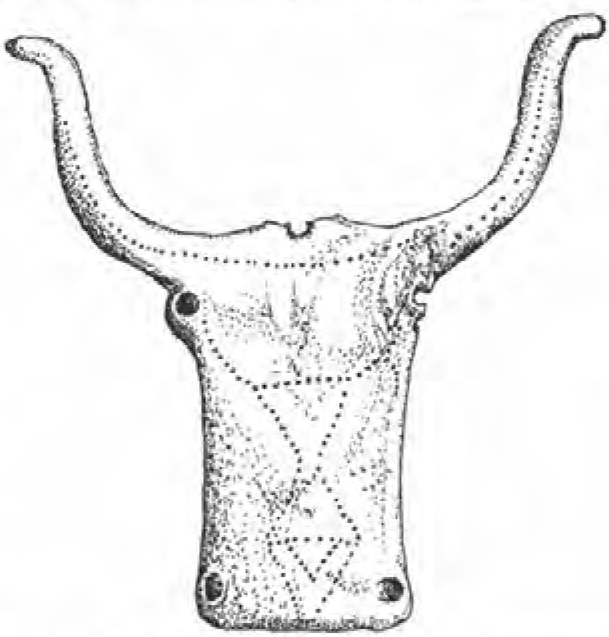
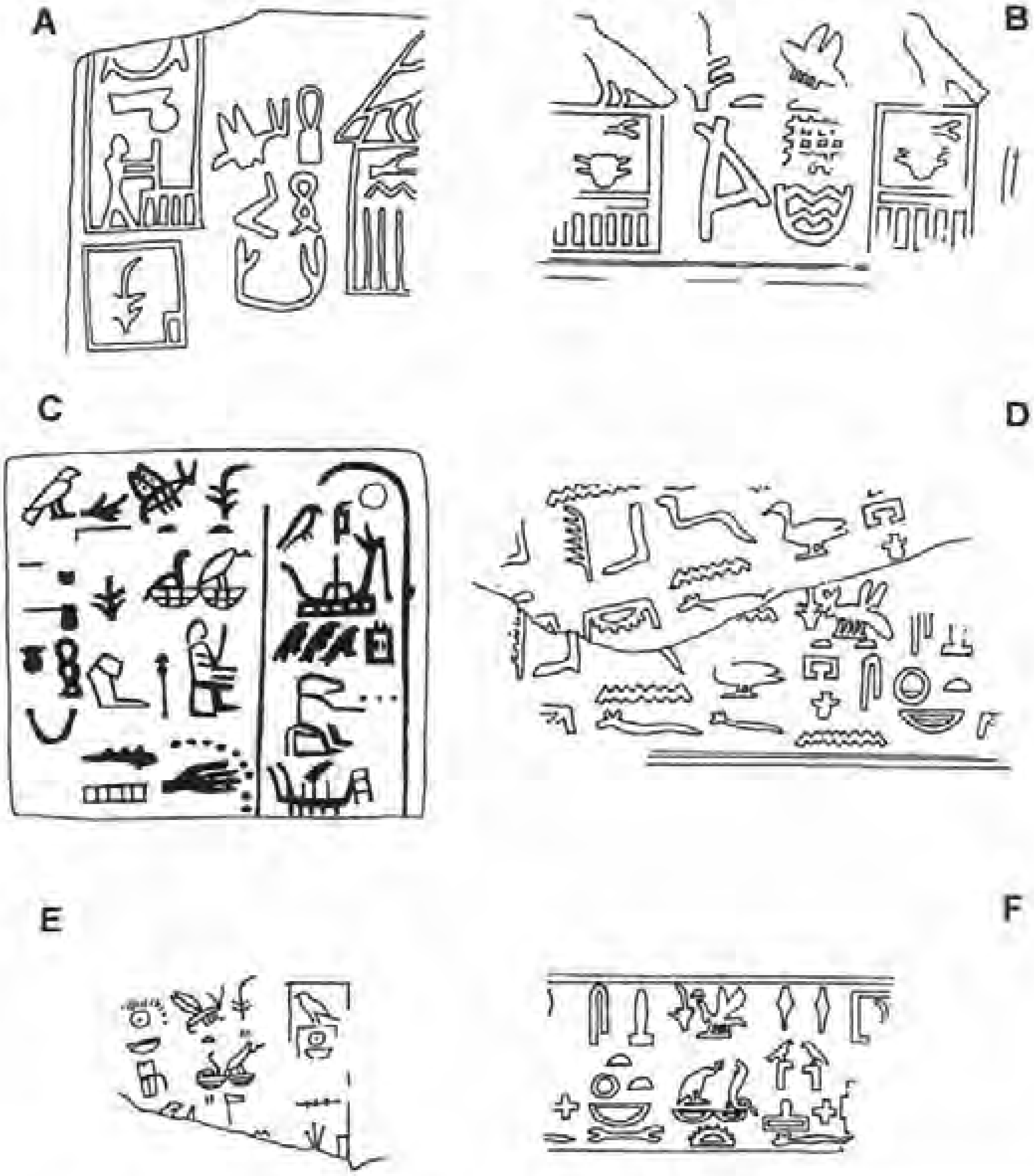


Figure 6.3b Goddess of Regeneration in the shape of a bee, with antennae, rendered on a stylized bull's head carved out of bone, height 17 cm, Bilcze Zlote, Ukraine, Late Cucuteni, 4000 to 3500 BC (after photograph by Gimbutas, 1974).

From the establishment of the First Dynasty in Egypt about 3100 BC until the period when the Ptolemies ruled the country in the 330s BC, the honey bee was much portrayed because it was part of the topographical symbol of Egypt and of the King's titulary. The accepted reason for this is that beekeeping was already very important before 3000 BC, especially in the Nile delta (Hassan Khattab, 1988, also Section 20.2). Thousands of such representations of a bee can be found in Egypt and in Egyptian museums throughout the world. The bee was viewed from the side, and showed both antennae and at least 2 of the 4 wings and 3 of the 6 legs, but the style of the representation necessarily varied according to the surface used. Figure 6.3c shows examples from the first two Dynasties, between 3100 and 2686 BC. Later, segments of the abdomen became more clearly delineated, although rarely in the correct number (6 are visible). By about 2400 BC in the Fifth Dynasty one hind leg was shown, but it sometimes appeared to come from the abdomen instead of the thorax. By around 1500 BC the bee was depicted more realistically and to a much larger size on stone surfaces (Figure 54.5d).

In Australia, there is a long tradition – said to be unchanged for 10,000 years – of painting on bark stripped from certain *Eucalyptus* trees (Tettamanti,



1983). An example depicting two nests of stingless bees is shown in Figure 11.5c, which may be compared with the rock painting in Figure 11.5a. The age of these Australian paintings is not known.

Figure 6.3c Some early representations of the sedge and the bee, in the title of Kings of Egypt of the 1st and 2nd Dynasties, from their tombs (from the British Museum Catalogue, by courtesy of the Trustees of the Museum).

Surface	*King*	*BM No.*
First Dynasty (*c.* 3100-2890 BC)		
A ebony label	Den	EA 32650
B clay sealing	Adjib	EA 32660
D ivory label on grey marble bowl	Semerkhet	EA 32668
Second Dynasty (*c.* 2890-2686 BC)		
D clay sealing	Peribsen	EA 35594
E bowl of volcanic ash, carrying the name Ninetjer	Peribsen	EA 35556
F clay sealing	Khasekhemwy	EA 35592

7

Honey and Bee Hunting, with Examples in the Mediterranean Region and Middle East

7.1 The circumstances of opportunistic honey hunting

It was suggested in Section 6.1 that honey hunting by man (*Homo sapiens*) is as old as man himself and continued through both the Palaeolithic and Mesolithic periods when food was still obtained by hunting and gathering. Reader (1988) calculated the proportions of food obtained by hunting and by gathering among 56 hunter-gatherer groups studied in different parts of the world. Where the mean annual temperature was above 10°C, gathering was the principal source of food in 75% of the groups, and in colder regions hunting was more important. Observations on honey getting show that in the tropics and to some extent the subtropics honey was a seasonal treat, greatly valued for its sweetness, whereas in the cool temperate zone it was more systematically hunted as a food. Later Chapters give many examples.

Figure 7.1a Mesolithic rock painting showing honey collection from a wild nest, La Araña shelter, Bicorp, Valencia, Spain (Register AI-01, drawing: E. Hernández-Pacheco).

The rock painting in Figure 7.1a, described by Hernandez-Pachéco in 1924, was the first direct record found of Mesolithic honey hunting. In it, one person is climbing a ladder up a rock face, and another who carries a collecting bag is at the nest – which is actually a depression in the rock – and many over-large bees are flying around. In 1978 Dams published a more social Mesolithic scene (Figure 7.1b) in which four people are securely on a ladder, one is falling off, and 12 are clustered in a group on the ground, waiting for honey combs that might be dropped or brought down. Half a dozen large bees fly round the nest.

The term opportunistic honey hunting is used here for the activity of hunters who raided a bees' nest when they found one and harvested honey combs from it, but did not own the nest or take steps to preserve the bees. Such honey hunting continued to the present day among peoples living in a Stone Age culture, and was also practised to some extent by many peoples at much later stages of development who kept bees in hives: in Ancient Egypt, Greece and the Roman world; in Europe during the Middle Ages and later, and in North America from the 1600s. In many beekeeping communities, nests were also hunted to obtain bees to put in hives.

The bees and their nests remained almost unchanged throughout man's prehistory and history, and procedures for honey hunting by any one people changed little. Mesolithic honey hunting techniques shown in rock art have striking similarities to those used by present-day honey hunters among the same

Figure 7.1b Another Mesolithic rock painting showing honey collection, Barranc Fondo, Valencia, Spain (Register Al-02, Dams, 1978).

peoples, which have been observed, photographed and filmed. Honey hunting was usually practised by only a few individuals within a group, almost always men, and methods and rituals were handed down from father to son.

Circumstances in which opportunistic honey hunting was perpetuated included the following:

- a low density of human populations;
- their movement through quite a large area to find food;
- an excess of bees' nests over the number needed to supply human requirements for honey and wax.

The present Chapter deals with opportunistic hunting of *Apis mellifera* nests in the Mediterranean region and Near East, and Chapters 8, 9 and 12 do the same for other parts of the world. Chapters 10, 11 and 13 are concerned with opportunistic hunting of nests of other insects.

7.2 Nests in rocks and in trees

Cavity-nesting honey bees *Apis mellifera* and *A. cerana* live mainly in rocks and trees. Nests in trees are more accessible to man, and they have been much more studied and written about – partly because they occurred in cooler climates where most writers on bees have lived. The bees can nest in rocks only in warmer parts of the world; loss of heat through rock is too rapid to allow a colony to maintain its temperature during a cold winter. (The rate of heat loss through a material is proportional to its thermal conductivity, which is higher for earth materials than for beeswax of which the bees' combs are made, for instance clay 2-5 times, and granite 10 times as high. For plant materials the conductivity is lower, and so reduces heat loss: for several woods it is 50% to 90%, for packed straw or reeds 30%, and for cork only 16%, of that of beeswax.) Most *Apis mellifera* nests in trees were built in a cavity, but those in rocks might be more exposed and only partly enclosed, as in Figures 8.1c and 8.1e. There are several reasons for this. Nest entrances on a rock face could be larger because they were less accessible to predators than those in a tree. Regions where bees nested in rocks were usually too hot and dry for large trees to grow, and protection against rain was less needed. Also, nest sites were likely to be scarce, so the bees' choice was limited. Mesolithic rock paintings in Spain indicated *A. mellifera* nests inside cavities, probably in rock, but many later San (Bushman) paintings in dry parts of Southern Africa showed them as though the artist could see the combs of the nest.

Introduced *A. mellifera* builds nests in rocks as far north as Arizona in North America (Levin, 1989). *Apis cerana* lives in rocks in many parts of tropical Asia; in some areas it was called the rock bee, and as far north as China it was the source of so-called 'stone honey'. In tropical northern Australia stingless bees sometimes nest in rocks.

In some parts of the world, large trees had cavities in which honey bees made their nests, and a honey hunter usually had less difficulty in harvesting from such a nest than from one in rocks. A tree could be climbed, whereas a nest in rocks might be up a cliff face. Also, it was easier to break open a nest cavity in a tree: the wood could be chipped away, whereas

most rock could not, although in a few places honey hunters fractured the rock by alternate application of fire to heat it and water to cool it. A log containing a nest could be separated from a tree, if necessary after felling it, and taken home. A nest in rock could not be moved unless the rock was very soft; a few types such as tuff and loess are so soft that cavities were scraped out for bees to nest in (Section 16.4).

7.3 Honey hunting in the Ancient World

Here, as in many other contexts in this book, the only knowledge we have of events and practices before recent times comes from a few pictorial records and sporadic references and anecdotes; we have no continuous history. The earliest certain evidence of honey hunting consists of Mesolithic rock paintings such as those in Figures 7.1a and 7.1b.

Section 49.42 refers to copper objects, cast with the aid of beeswax, found in a cave in the Judean desert and dated to between 3500 and 3000 BC. Beeswax was used similarly in Sumer between 2500 and 2250 BC. There are references to honey from the first dynasty of Ur, about 2400 BC (Section 54.32), and from the empire established by Hammurabi with Babylon as its capital, *c.* 1500 BC (Section 21.1). No such early record of hive beekeeping in or near Mesopotamia is known. So the beeswax and honey were probably harvested from natural nests, possibly from the mountains of Habha (Section 21.1).

In 3000 BC or earlier (Section 20.7) the Egyptian god Min was referred to as 'master of the wild bees', and one official was responsible to the Pharaoh for mounting desert expeditions to collect wild honey, and also resin from terebinth (*Pistacia terebinthus*). A manuscript from the time of Ramesses III (1194-1163 BC) quoted him as saying to a god: 'I have made to you archers and collectors of honey to collect honey for you' (Breasted, 1962). The desert expeditions were presumably carried out in daylight, and since beekeepers at that time used smoke to pacify bees when they took honey from hives (Section 20.31), honey hunters probably also used it.

The Hebrew scriptures relate that Israel (Jacob) who lived about 1700 BC, told his sons to take as a present to their brother Joseph in Egypt 'some of the produce for which our country is famous ... a little balsam, a little honey ...' (Genesis 43.11, NEB). These scriptures refer many times to honey as plentiful in Canaan, and in four passages mention the source of the honey, or how it was obtained. The first and fourth refer to a period perhaps about 1700 BC and the others to 1100 or 1000 BC.

1. The Lord 'satisfied him [Jacob] with honey from the crags'. Deuteronomy 32.13
2. Samson 'turned aside to look at the carcass of the lion, and he saw a swarm of bees in it, and honey. He scraped the honey into his hands and went on, eating as he went.' Judges 14.8
3. 'Now there was honeycomb in the country-side'; Jonathan 'stretched out the stick that was in his hand, dipped the end of it in the honeycomb, put it to his mouth and was refreshed.' 1 Samuel 14.25-7
4. The God of Jacob 'satisfied him with honey from the rocks'. Psalm 81.16

There have been many discussions as to just how these passages should be rendered in English (e.g. Bodenheimer, 1934), but 1 and 4 refer to nests in rocks, and 2 to one in a (dry) lion carcass; 2 and 3 describe the actions men took when they came across a bees' nest – which are similar to those observed more recently in both man and the chimpanzee (Section 5.4). There is no mention of bees' nests in trees or in hives, or of methods used to locate nests.

Several early references quoted by other authors testify to the abundance and good quality of honey in Arabia. Around 1000 BC, the celebrated Chatramotitis honey in Thugba and Irma valley in Saba was the only product of economic consequence other than incense (Tersiesi, 1968). Much later, Pliny said that the Sabaei in the extreme south were 'the most wealthy people owing to [various natural resources, including] their production of honey and wax' (VI.32.161). Strabo had quoted Eratosthenes (*c.* 276-196 BC) as saying that Arabia 'abounds with places for making honey' (XVI.4.2). Tersiesi referred to Pliny's quotation from Yule's *Gulyas* (25 BC), that 'honey bees are abundantly distributed in crevices in rocks and mountains; the most famous area in Arabia is Beni Saleem Mountains', and there is a further comment that 'some people are well acquainted to climb up and down in accessible crags to collect honey'.

Homer was the first Greek writer to refer to bees. In the *Iliad* (II.87) he used the simile: 'Even as when the tribes of thronging bees issue from some hollow rock, ever in fresh procession, and fly clustering among the flowers in spring, and some on this side and some on that fly thick.' Later (XII.105-6) he referred to a cave in Ithaca (off the west coast, near Kephalonia) where 'there are mixing bowls and two-handled jars; and the bees store up honey there'. Empty jars left in the cave had probably been occupied by swarms.

Honey hunters featured in a legend concerning Zeus, the supreme God of Olympus in Greece, and

Figure 7.3a Decoration on a vase from the Etruscan city of Volci, dated to c. 540 BC, showing mythical honey hunters in a cave on Mount Dikte, Crete (British Museum Cat. no. B177).

Cook (1895) told the story as follows. When Zeus was an infant, his mother Rhea concealed him in a cave in Mount Dikte (Ida) in Crete, where he was fed on honey from sacred bees there. One day, four men protected themselves with armour and entered the sacred cave to steal honey. They began to take it, but at the sight of Zeus the joints of their armour burst and it fell off, leaving their bodies unprotected against the bees. The amphora in Figure 7.3a is one of two vases decorated with a picture of the naked men trying to beat off the bees.

We know little of honey hunting in Italy before or during the time of Ancient Rome, but Cicero (106-43 BC) referred to slaves collecting wild honey from the forests (*De senectute*, Beck, 1938), and Columella described a method for locating nests which is quoted in Section 7.5.

Diodorus Siculus (60-30 BC) wrote of the Corsican people when they were subject to the Etruscans; they paid tribute in resin, beeswax and honey: 'They fed on milk, honey and flesh, which the country offers plentifully, and they excel all other barbarians in justice and humanity one towards another; for where any find honey in a hollow tree in the mountains, it is certainly his that finds it, without any further dispute' (*Historical library* V.13.4).

7.4 Honey hunting in later centuries

Honey hunting was little referred to after the Western Roman Empire ended in AD 476, probably because by then hives were used for honey production in much of the Mediterranean region. It doubtless continued, and there is a description from Arabia in a poem compiled during the 500s by a mulatto, Thabit ibn Jabur – one of the 'Ravens of the Arabs' and a superb runner – to commemorate an unusual exploit. His companions had let him down a cliff face by a rope, to collect honey from a cave, when hostile tribesmen attacked and defeated them, and then demanded that he should give himself up as their prisoner. But he kept them talking while he 'poured forth the honey upon the rock from the mouth of the cave; then he bound upon his breast the skin in which he had stored the honey, and spread himself out upon the slide thus prepared. And he did not cease to slide down thus, kept from slipping by the tenacity of the honey, until he reached the level safe' (translated by Lyall, 1885).

The prophet Muhammad, who lived in Mecca and Medina (AD 570-632), mentioned bees and honey in the Koran (Sura 16.68), including the words: 'thy Lord inspired the bee, saying: Choose thou habitations in the hills and in the trees ...'; it seems likely that the habitations in the hills were in rocks, since trees were mentioned separately. There is a record

of honey hunting near Jerusalem in the 900s, and in 1540 in Cyprus, when bees were also kept in hives (P. Androudis; Fr. Igoumenidou; see Nikiti, 1966).

Whitcombe (1985) quoted some travellers' reports in Arabia since 1830; several refer to wild honey as a delicacy and a few to honey hunting, which continued after hive beekeeping had started. In northern Hajaz, bordering the Red Sea coast, Wellsted (1838) considered honey to be one of the principal foods of the Bedouins; it was obtained from bees that 'live in hollows of the rocks'. Honey was also taken by smoking bees from their nests in rock crevices in the deserts of Inner Arabia. A tribe of savage men was reported near Kheybar 'who are very long-lived and of marvellous vigour in their extreme age, as they are nourished of venison and wild honey' (Bodenheimer, 1951). Doughty (1888) referred to wild honey 170 km north of Medina, and Whitcombe (1984a) quoted a 1908 report of beeswax as a hill product in Dhofar District, now in Oman. Even in the 1970s, honey combs were obtained there from nests of native *A. mellifera jemenitica* in steep cliff sides.

Apis florea is present in southern parts of Iran and the eastern part of the Arabian peninsula opposite, and its honey was harvested as described in Sections 10.4 and 19.22.

There are recent descriptions of honey hunting in the Eastern Mediterranean region. In limestone hills in Palestine such as those north of Akko (Acre), many rock crevices and cavities were occupied by bees, and 'not a few desert Bedouins made a living from harvesting and selling their honey' (Buttel-Reepen, 1921). In the Baruk mountain forests of Lebanon, few colonies of honey bees nested in trees, but many in fissures in rocks, most of which were horizontal (Yazbek, 1989). Every year specialist honey collectors went there and harvested honey. They were let down from the top of the rocks by a rope, latterly wearing a metal gauze face mask held in position by the customary headcloth, and socks over the hands. The smoker consisted of glowing charcoal on a flat piece of tin, and the smoke produced was directed by blowing. If the entrance to the nest was too small, the man might enlarge it by using a charge of dynamite. When his bucket was filled with honey combs it was raised to the top by the rope, which left the honey collector without any safety line and, on several occasions, a mass attack by bees from a harvested nest resulted in his falling to death on rocks below: one of the places where the nests were found is named Sannine, 'valley of skulls'. (In Turkey, honey hunters sometimes blasted the rocks, or struck and broke them, to open the nests, and then used water or smoke to get rid of the bees.)

Section 47.2 describes how Xenophon's soldiers were poisoned near the north coast of Asia Minor in 399 BC, by eating honey – which may have been collected from bees' nests in trees, or possibly hives. In the 1900s honey hunting was still practised throughout Asia Minor (the Asiatic part of Turkey), although traditional beekeeping was well developed. Forests included especially pine, oak and walnut, all of which could provide sites for nests. Bodenheimer (1942), who collected information directly from individual Vilâyets (Districts) in 1937, recorded honey hunting in 70% of them, and had personal knowledge of it in some others. During the season, it was a favourite sport enjoyed by organized parties. In some places colonies were destroyed, but in others – such as Manyas near the north coast – they were preserved. In forests of the southern parts of Edremit, between Izmir and Troy in the west, colonies were smoked through a hole bored in the trunk, level with the nest.

In many parts of Turkey rock cavities provided nest sites – some recorded as 5 or 6 m deep – and in the north, Trabzon (Trebizond) and neighbouring Vilâyets were famed for their 'honeyed' mountains. In Central Anatolia, some of the nests in rocks became so hot during the summer that combs melted and honey trickled down the face of the rock, where villagers collected it. Part of Cappadocia in Central Anatolia is formed of soft volcanic tuff, and this provided many nest cavities to which honey hunters could fairly easily gain access. In various parts of Turkey honey was also harvested by digging out underground nests.

Much less is known about honey hunting in lands south and west of the Mediterranean. In Libya in North Africa, bees nested in rock fissures in the steep sides of wadis 100-200 m high (Saad, 1989), but not in the 'green' mountains above. Strong winds could blow along the wadis, which made it difficult for laden bees to fly up to their nests, and too dangerous for men to climb to them to collect honey.

After Muslim Arabs crossed from North Africa to Spain in 711, and conquered much of it, one of their rulers had four residences: 'In spring he moves to the city of Mérida because of the abundance of the chase [game], butter and honey' (Monferrer, 1991). But perhaps the honey came from hives.

7.5 Bee hunting

Bees in natural nests might be collected for two purposes. Especially as brood, they were a valued food among many peoples. Also, after hive beekeeping began, the adult bees of a colony – with the queen – were widely used to populate a hive.

The use of bee brood as food is discussed in Section 51.6. It was especially important in certain tropical rain forests outside the Mediterranean region, where bees foraged almost all the year round because there was no really dry season, and some plants were always in flower. Colonies there built comb and reared brood throughout the year but might store little honey. Peoples in such forests took frequent harvests from the nests to collect brood and pollen (protein); in addition, honey was a special seasonal treat. Examples are in Sumatra in Asia (Tamiji Inoue, 1984) and Zaire in Africa (Turnbull, 1966; Ichikawa, 1981).

When hive beekeeping began in any area, nests might be hunted to collect the adult bees and queen to put in a hive. The bee hunter had to capture the bees and queen and transport them safely to a hive, often through some distance over difficult terrain. Sometimes the part of the tree containing the nest was cut off and transported with the combs and bees in it.

The earliest record of methods for locating a nest is probably Columella's, written about 65-60 BC.

> Wherever there are suitable woodlands where honey can be gathered, there is nothing that the bees would sooner do than make choice of springs [of water] near at hand for their use. ... If they come and go in large numbers, they inspire greater hopes of our catching swarms of them [taking colonies]; and the following is the method of finding them. First we must try to discover how far away they [the nests] are, and for this purpose liquid red-ochre must be prepared; then, after touching the backs of the bees with stalks smeared with this liquid as they are drinking at the spring, waiting in the same place you will be able more easily to recognize the bees when they return. ... If you notice them returning quickly, you will have no difficulty in following the course of their flight and will be led to where the swarm [colony] has its home. As regards those who apparently go farther away, a more ingenious plan will be adopted, as follows. The joint of a reed with the knots at either end is cut and a hole bored in the side of the rod thus formed, through which you should drop a little honey or boiled-down must. The rod is then placed near a spring. Then when a number of bees, attracted by the smell of the sweet liquid, have crept into it, the rod is taken away and the thumb placed on the hole and one bee only released at a time, which, when it has escaped, shows the line of its flight to the observer, and he, as long as he can keep up, follows it as it flies away. Then, when he can no longer see the bee, he lets out another, and ... another, and marks the direction in which most of them fly home, and pursues them until he is led to the lurking-place of the swarm [colony]. (*De re rustica* IX.8.7-10)

If the colony was inside a tree, the section containing it was cut off and carefully carried home; if it was in a cave, it was driven out with smoke. Columella added: 'The searcher for swarms should choose the morning for his search, so that he may have the whole day to spy out the comings and goings of the bees.'

Variants of the above method, referred to in other Chapters, were used in many parts of the world. Bee hunting became well established in North America after *Apis mellifera* was introduced there, and Dudley (1721) developed Columella's method further; see Section 12.22.

In more recent times, and possibly earlier, where colonies nesting in rock crevices were impossible to reach, swarms that issued might be captured instead. For instance, in mountains of Arabia where nests were too inaccessible even for harvesting honey, empty containers were set up near each nest at swarming time, to serve as bait hives. The beekeeper visited them every few days and carried down to his apiary those already occupied by a swarm. There was a high occupation rate, suggesting a shortage of natural nest sites in the area.

8

Honey Hunting in Africa South of the Sahara

8.1 Introduction

Travelling south from the Mediterranean along the Nile valley, through the dry Sahel and into tropical Africa, we enter regions with much good bee country. Rich traditions of honey hunting have continued within living memory, and we can thus learn much about honey hunting in the past. The honey bees are *Apis mellifera* as in Europe and North Africa, but they are tropical ecotypes which show important differences in behaviour. Firstly, they defend their nests very vigorously, to protect them against the dangerous predators in the region (Section 5.3). Secondly, they evolved to store honey for only short dearths; and also temperatures are often high enough for the colony to fly off to a new area which will provide alternative forage (Section 4.5). Both characteristics are less developed in bees at high altitudes where the climate is cooler.

Some parts of Africa south of the Sahara are even drier than Mediterranean lands, and the bees nest in rocks. Others are covered with tropical rain forest or open woodland known as *miombo*, where trees provide both forage and nest sites. In many regions, the number of natural honey bee nests that exist now is only a small fraction of that when the human population was more sparse: for Africa this is now over 600 million, but 2000 years ago was only 3-4 million.

In places where neither rocks nor trees provided nest sites, honey bees might build in a hollow below ground or an abandoned termite nest, and sometimes in an open rock depression or in the shade formed by leaves or branches of a tree.

8.11 Rock art

Section 6.2 discusses early paintings on rock surfaces that depict bees' nests and honey hunting. Most of the known rock art relating to bees was the work of San people (Bushmen) who lived in hot dry areas of Southern Africa where some nest sites were also in rock. The bees could survive in a site not completely enclosed, and nests the people saw may have been built down from a rock overhang or at the entrance to a rock hollow or cleft.

Sometimes a nest was drawn as seen *from the front*, and shows a series of 'catenary curves' as in Figure 8.1a; many flying bees (not shown) are sometimes painted near them. Figure 8.1b is a photograph of an actual nest at the entrance to a rock hollow, and Figure 8.1c shows another rock painting. I believe that many similar paintings also represent combs in the nest; this was the opinion of Woodhouse

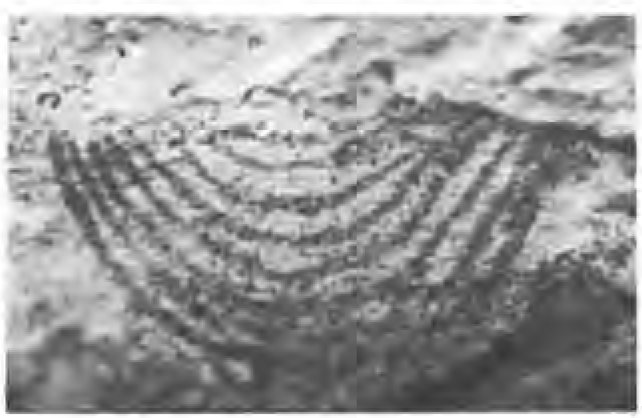


Figure 8.1a Catenary curves representing an *Apis mellifera* nest seen from the front, Botha's Shelter, Ndedema, KwaZulu Natal, Drakensberg, S. Africa (Register SN-14, photo: R. Guy).

Figure 8.1b Actual nest of *A. mellifera* at the entrance to a rock hollow, seen from the front, Arizona, USA (photo G.M. Loper).

(1982, 1989, 1990) and Genge (1994), although not of Garlake (1987, 1988) and some others.

Sometimes combs were viewed *end-on*, as in the painting in Figure 8.1d where ladders are in position for reaching two nests, and in the photograph in Figure 8.1e. Combs are also seen end-on in the photograph of an empty nest in Figure 3.1a.

Many rock paintings in Southern Africa show a group of somewhat similar compartments (Figure 6.2a, E), which Frobenius referred to in 1931 as a 'formling' (Pager, 1973). There was divergence of opinion as to whether all formlings, or some (if so, which, and on what basis), or none (Petie, 1986; Garlake, 1987, 1988), could be designated honey bee combs, in the absence of corroborative bee-related evidence. Woodhouse (1982, 1989, 1990) and Genge (1994) supported the view that Frobenius' formlings represent bees' combs as San people would probably have seen them, *from below*, and I share this view (see the photograph in Figure 6.2c). Most nests would be above the height of a man. Genge (1994) found these unexplained shapes in practically all major painted sites he visited during his many years of work in Zimbabwe (especially in the Matopos); 163 sites have already been recorded. Some formlings contained a regular pattern of dots, which he interpreted as representing cells in the comb; they can be seen in Figure 8.6a and Figure 6.2a (E, top, second comb from right). Some are associated with bee-related motifs, and others with animals that had a special symbolic significance for the San.

Genge suggested further that the motifs might not have been intended to represent actual bees' nests or combs, but rather the power – magical or otherwise – and sweetness of honey comb. The more combs painted at a site, the greater would be the power of the offering being made. Woodhouse (1989) referred to a suggestion by Robin Guy that honey combs were painted on a rock surface where a swarm might be expected to settle and build combs, in order to persuade one to do so. Huffman (1983) stressed the potency of bees among various other trance figures in the San rock art of Zimbabwe, and drew attention to paintings in which a human mother goddess is surrounded by several hundred flying bees: one is in Vumbiga Cave near Mtoko (ZN-106).

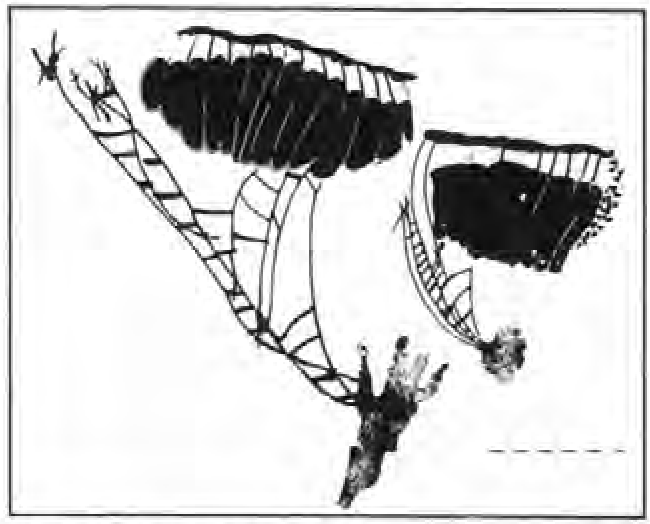


Figure 8.1d Rock painting of *A. mellifera* nests seen end-on, with honey hunters' ladders in position, Anchor Shelter, KwaZulu Natal, Drakensberg, S. Africa (Register SN-03, copy by Pager, 1971).

Figure 8.1c Rock painting similar to Figure 6.1a but also showing bees, Eland Cave, KwaZulu Natal, Drakensberg, S. Africa (Register SN-01, copy by Pager, 1971).

Figure 8.1e Actual nest of *A. mellifera* at the entrance to a rock hollow, seen end-on, Arizona, USA (photo: G.M. Loper).

Table 8.1A

Motifs in rock art believed to relate to bees, found in African countries

Updated from Crane (1983a), from records by Pager (1975b, 1981) and Register of rock art (to 1997)

x = one site, xx = several, xxx = many

	Catenary curves	*Frobenius' formlings*	*Ladders*	*'Swarms' of bees*	*Honey hunter at nest*
Algeria	x	x		x	
Libya			x		
Malawi	x				
Morocco	xx				
Tanzania	x			x	
Zambia	x	x			
South of the Zambesi River					
Botswana			x		
Lesotho			x	x	
Namibia	xx	x	x	x	
South Africa	xxx	xx	xxx	x	xx
Zimbabwe	x	xxx	xxx	xxx	xx

Table 8.1A shows where in Africa different bee motifs are used in rock art; San rock art is mostly found in Southern Africa, south of the Zambesi river.

8.12 Written records from AD 1000 onwards

In many countries honey hunting retained its importance even into the late 1900s; for instance in recent decades 90% of the honey marketed in Ghana was from honey hunting, and in Madagascar 80% (Fert & Fert, 1988). Table 8.1B cites records from individual countries, most published since 1970.

Some of the Arab traders who travelled through tropical West Africa in the Middle Ages mentioned honey (Lewicki & Johnson, 1974). Several commented on its abundance, for instance at Audaghast north of the Senegal river in 1067 where it was brought 'from Negroland', and in Senegal in the mid-1100s. Honey was an article of commerce, and its exceptional cheapness was noted, for instance in Senegal in or before the 1200s. In 1352 Ibn Battuta went to Mali from Walata, west of Timbuktu and on the southern edge of the Sahara; on his way he saw 'trees of great age and girth ... Some of these trees have rotted in the interior, and rain water collects in them ... In others there are bees and honey, which is collected by the people.'

Later European explorers also recorded honey hunting. Vasco da Gama from Portugal was the first to round the Cape of Good Hope and sail on along the east coast. In November 1497 his ships spent 8 days in St Helena Bay 200 km north of the Cape; while on land, he and his companions captured a man 'small of body' who was 'going about gathering honey on the moor' (Anderson, 1985). In 1660/61 Jan Danckaert explored the hinterland of Table Bay settlement (Cape Town), partly to engage in trading honey and wax. North of Heuningberg (Honigberg) his party surprised a group of San men carrying sacks of honey and other food. Tribe (1996) gave details of this and other incidents. Many later travellers, including François Valentyn (or le Vailliant) in 1726, commented on Honigberg in Cape Province, 'named from the abundance of honey there, which is bought in the comb by the Hottentots [Khoi people]'. Valentyn also visited indigenous forests near the south coast, whence San people carried honey they collected (probably from Cape bees, *A. m. capensis*; Tribe, 1982) in bags made from antelope skin, across a pass over the Outenique mountains, to barter it for other goods from the Khoi (Peagam, 1977). He noted that the name Outeniqua was a Khoi word meaning 'a man loaded with honey' or 'bags of the honey people'.

Seyffert's *Biene und Honig im Volksleben der Afrikaner* (1930) provided much incidental information on honey hunting in the period between 1800 and 1930, and publications listed in Table 8.1B include later descriptions. But overland travel was fraught with dangers from disease, animals and local peoples, and the interior of tropical Africa was not explored until long after the coast was known. The extensive journeys of Livingstone and Stanley were made between 1852 and 1890.

8.13 Recent field studies

What is shown in the earlier rock art has close similarities to honey hunting methods observed in recent field studies. These give much more information about the part honey hunting played in the lives of

Table 8.1B

Records of opportunistic honey hunting, and of ownership of natural nests of bees, in African countries south of the Sahara

Publications marked * are anthropological or ethnological field studies. An entry *yes* or *no* is based on a publication cited in the same line.

	Opportunistic honey hunting		*Ownership of nests*	
Country	*Honey bee*	*Stingless bee*	*Honey bee*	*Stingless bee*
Botswana	Clauss (1989)	Nkomo (1989)	yes	
Burkina	Rigau & Campi (1990)			
Burundi	Dubois & Collart (1950)	yes		
Cameroon	Paterson (1989)	yes	no	no
	Silcock (1988)			
Central African Republic	Bahuchet (1972, 1975*, 1985)	yes	no?	no?
Chad	Svensson (1978)			
Congo Republic	Onore (1980)		no?	no?
Congo Dem. Rep. *see under* Zaire				
Djibouti	no		Petersen (1989)	
Eritrea	Fougères (1902)			
Ethiopia		1886 (Seyffert, 1930)		
Gabon	Darchen (1975)			
Ghana	Anno (1973)			
	Adjare (1989)		no	no
Guinea-Bissau	Svensson (1984)	yes		
Ivory Coast	Borneck (1976)			
Kenya	Mwaniki (1970)*	1886, 1911		
	Nightingale (1983)	(Seyffert, 1930)		
	Jackson (1992)			
Liberia		1890 (Seyffert, 1930)		
Madagascar	Fert (1985)	Chandler (1975a)	yes	
Malawi	Klinger (1989)			
Mozambique	Griffiths (1977)			
Namibia	Pager (1972)		yes	
Nigeria	Mutsaers (1989a, 1989b)	yes	yes	
Rwanda	Dubois & Collart (1950)	yes		
Senegal	Gessain (1974)	yes		
	Gessain & Kinzler (1975)*	yes	yes	
Sierra Leone	Silberrad (1986)			
Socotra	Forbes *et al.* (1903)			
Somalia	Douthwaite (1985)			
South Africa	Stow (1905)	1881 (Seyffert, 1930)	Stow (1905)	
	Guy (1972)	Valoyi (1984)	Guy (1972)	
	Mahalefele (1989)			
Sudan	Brown (1984)*	yes	no	no
Swaziland	Bechtel (1989)	yes	no	no
Tanzania	Woodburn (1965, 1968)*	Crosse-Upcott (1958)*		
Togo	Petitjean (1975)	no?	no?	no?
Zaire	Dubois & Collart (1950)	yes		
	Cotlow (1957)			
	Turnbull (1961)*			
	Ichikawa (1981)*	yes		
	Takeda (1990)*	yes	no	no
Zambia	Clauss (1988)			
Zanzibar	Seyffert (1930)			

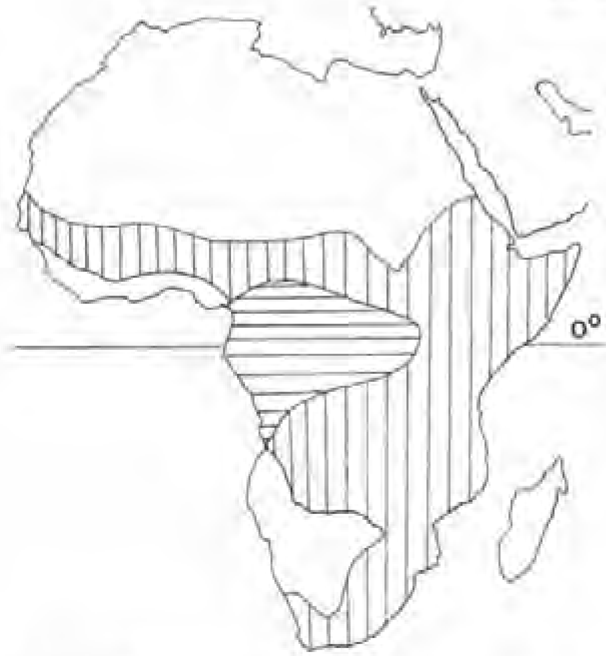


Figure 8.1f Map of tropical Africa showing areas where the greater honeyguide is found (Short, 1989), and where Pygmy peoples live in rain forests (Silcock, 1988).
vertical hatching: greater honeyguide
horizontal hatching: Pygmy people in or near this area

different peoples, and suggest that some groups of hunter-gatherers obtained sufficient food without undue effort (2 hours a day by the Hadza in Tanzania; Woodburn, 1968); they had a happy life on the whole, and old people among them were cared for and respected and might survive to a good age (Barraclough, 1978).

Pygmies in rain forests of equatorial Africa (Figure 8.1f) still follow a hunter-gatherer way of life, and they seem to get more pleasure from the honey hunting season than any other in the year. Ichikawa (1981) recorded the results of 12 days' honey hunting by six Mbuti Pygmies in Zaire. They harvested between 5.5 and 32.5 kg of honey daily, from between 1 and 10 honey bee nests, and on 4 days they also got 5-7 kg from a nest of stingless bees. Their average daily honey harvest was about 19 kg. Ichikawa stressed the social significance of honey hunting. When the honey season began, a large camp split up into small groups. The men in each group hunted together and lived mostly on honey, which constituted 70% by weight of their food during the 12 days of the hunt. Life in the small groups 'helps the settlement of various disputes which normally arise when many people live together' as they do during the season when they hunt animals using nets. Also in the Zaire rain forest, the Ngandu practised slash-and-burn agriculture and hunted for bees' nests (Takeda, 1990).

In the Wum area of nearby Cameroon only rather primitive honey hunting was known, and the colonies raided were usually destroyed. The honey hunters were often away from home for several days, and returned with as much honey as they could carry (Paterson, 1989).

To many peoples, honey was the most important and exciting part of the harvest, whether from nests of honey bees or stingless bees. To the Ngindo, a Bantu-speaking people in southern Tanzania, honey was more tasty and more sustaining than bush fruits; also, a poor honey season did not necessarily coincide with crop failure. To them, honey could also be a vital subsistence food in times of famine (Crosse-Upcott, 1958). Songs of the San people testify to its similar value in the Kalahari in Botswana. The following verses are quoted from Markowitz (1971).

Hunter's Prayer
I am weak from thirst and hunger.
  Abo Itse,* let me live ...
Let me find sweet roots and honey,
  let me come upon a pool.
Let me eat and drink. Ho Itse*,
  give me that which I must have.

Hunter's Dance
Look! The people carry honey,
also flesh. They bring it home
to the women who are hungry,
that the women may have food.

In Botswana the people noted that bees could also face starvation, and that they reacted to it 'by tearing down sealed honey combs' (Heinz, 1978).

Honey hunters needed to be strong and agile; they were commonly young men and boys, as in Senegal (Gessain & Kinzler, 1975), or young boys, as in Guinea-Bissau (Svensson, 1984). In Lesotho herd boys – usually young – hunted for the few wild colonies that remained (Mahalefele, 1989). But in southern Sudan both young and older men of the Ndogo were honey hunters.

Among most peoples, women might or might not collect honey from nests of stingless bees, but they did not collect it from honey bee nests except in an emergency. Their help was, however, little appreciated by the men, who ridiculed their inexperience:

*Great Father

There's famine in Kilingula,
The womenfolk climb for the bees.
Their *kimbundi* (smoker) is clothing,
Their *ntulakilo* (bark rope) is beads,
There's famine at Kilingula.

Kilingula is an agriculturally poor area, liable to crop failure (Crosse-Upcott, 1956).

Nests contained most honey during one or two periods of the year, after the end of a major honey flow. Honey hunting was essentially a seasonal occupation, and was carried out at different levels of knowledge and expertise. At the lowest level, the hunter was ignorant of the bees' seasonal cycle; he attacked any nest he found, destroying both the nest and the bees (usually by fire) and taking what he wanted; the rest was discarded. Borneck (1976) referred to this in the Ivory Coast. At the highest level, a group of honey hunters spent several weeks in the forest at the appropriate season, locating nests and harvesting honey combs, but leaving enough for the colonies to survive and build new combs for the next season; the Mbuti (Ichikawa, 1981) are one example.

Some peoples collected honey at night (from either nests or hives), using a torch to give light and a smouldering bundle of vegetation producing smoke to drive the bees away and discourage them from stinging the honey collector. I found no records of the use of protective clothing by traditional honey hunters. Some tried to protect the face with their clothing, but often they removed clothes because bees easily became trapped in them; many worked naked, as the Bviri did in southern Sudan (Brown, 1984).

8.2 Preparations, and methods of finding honey bee nests

Various rituals and taboos had to be observed before hunting for honey, and those observed in recent years are probably long-standing. Sexual abstinence was commonly required. For instance, among the Bassari in Senegal, a group of men who were going into the bush on a hunting expedition had to refrain from sexual relations for the previous two or three days. If this taboo was broken the offender had to confess to the others, who decided on his punishment, and he himself could not go on the hunt. Also, it was believed that a husband would be wounded while he was away hunting, if his wife then had sexual relations with another man (Gessain & Kinzler, 1975).

A nest might be found by chance, either when bee activity round its flight entrance was noticed by someone scanning the trees for a monkey or squirrel to shoot, or when a humming sound was heard, as Anno (1973) described in Ghana. Men who knew the locations of nest sites harvested in earlier years might revisit them in case they had been occupied by a new swarm (for instance in South Africa, Guy, 1972). Reoccupation could occur only if a nest site had been left in a suitable state after the previous harvest. Other things being equal, the reoccupation rate was most likely to be high where there was a scarcity of suitable nest cavities.

Some honey hunters with keen eyesight looked for bees' droppings (faeces) on leaves – for instance the San (Hahn, 1870) and in Madagascar (Fert, 1985). Pager (1972) quoted a German report of a mountain people in the Okombahe Reservation in Namibia who went to the Brandberg each year in the honey-collecting season. By tradition, a honey hunter would observe bees collecting water, as described by Columella (Section 7.5), but when he had established the direction of the flight of the bees as far as the horizon, he would take up the trail following bee droppings, 'here a spot, there a spot', which were barely visible to the unpractised eye. If he was overtaken by night in a place too far from home, he would set up camp and follow the trail again at first light. From the colour of the droppings he could deduce whether the nest was near or far away. Whereas Columella caught bees and marked them with ochre so that they were easier to follow, the San tied a fine thread on them (Guy, 1972). In the evening the bees (even without a tell-tale thread) would 'fly straight to their habitation, and with their keenness of vision a San hunter would be able to detect the direction which the industrious insects took. This they would follow, still watching for returning bees, until at last they came to the spot where the nest was hidden. Should they pass ... it they would soon perceive that the bees were coming from the opposite direction' (in South Africa, Stow, 1905). In the evening, honey hunters looked uphill towards the setting sun, watching for the shimmering wings of flying bees (in Swaziland, Bechtel, 1989). Searches were usually made in early morning or late evening.

A Mbuti in the Ituri forest might find 2 or 3 nests in an hour or two (Ichikawa, 1981), but in dry bush country a Boran could take 9 hours; see Section 8.3. In general, honey hunters did not like to spend many days on a hunt, camping in the bush away from their homes and families. Among the Ndogo people in southern Sudan (Brown, 1984), a group of honey hunters stayed away for 3 or 4 days, travelling 8-10 km. They did not return until each man's containers were full of honey. He carried two, balanced on the two ends of a branch resting on his shoulder, and the

total harvest probably amounted to 50 kg of honey per person.

Honey hunters might enliven the journey to the nests by singing. Two of many songs recorded by Brokensha (1982) from the Mavuria people of Kenya, translated below, suggest that the travelling was not easy.

I am going to struggle with the tall plain grass of Mwea
To go for honey which is at Mbinduri
And also at Mbandaka.
We are struggling with darkness
While the drunkard is full of the water of fire.
Take me to the valley of Miugu
Where Kathenje is collecting honey from honey combs.

8.3 Partnership with a bird (the honeyguide)

Honey hunters in much of tropical Africa had a unique helpmate in the form of a bird, and this partnership between man and bird is so extraordinary that it is described in some detail.

The bird is the greater honeyguide (*Indicator indicator*). It has a wide distribution (Figure 8.1f), bounded on the north by the Sahara which stretches from Mauritania to northern Ethiopia. In the south the bird is found as far as north-eastern Namibia, northern and eastern Botswana, and from Natal to Cape Province in South Africa. But it does not live in true deserts, extensive grasslands, or extensive forests such as those in the Congo basin (Short & Horne, 1985). Nor does it reach the forested coast of West Africa; it needs trees in open vegetation to perch on, where it will be conspicuous.

Behavioural patterns of the honeyguide enable it to obtain access to honey bee nests by co-operating with a large mammal, including a human being. They were studied for three years by Isack and Reyer (1989) in the dry bush country of northern Kenya, and Isack was a member of the nomadic Boran people there. The authors set up camouflaged observation positions near a honey bee nest, and occupied them before dawn. They watched honeyguides visit the nest one at a time, and inspect it for about a minute. The bird then attempted to attract the attention of a possible 'partner' – a person walking through the bush. It flew close to him, moving restlessly between conspicuous perches around him, persistently making a call that sounded like 'tirr-tirr'. Then the bird flew off, displaying outer white tail feathers, and subsequently perched and called again. A Boran honey hunter would respond to the bird by whistling and making certain noises to keep its attention. A penetrating whistle was produced by blowing air into clasped fists, modified snail shells, or hollowed-out doum palm nuts. Sonograms showed that the human call stimulated the bird to call more frequently, and doubled the hunter's rate of encounter with it. The pattern of leading by the bird and following by the honey hunter continued until the nest was reached; then the bird's call changed and was no longer affected by human calls.

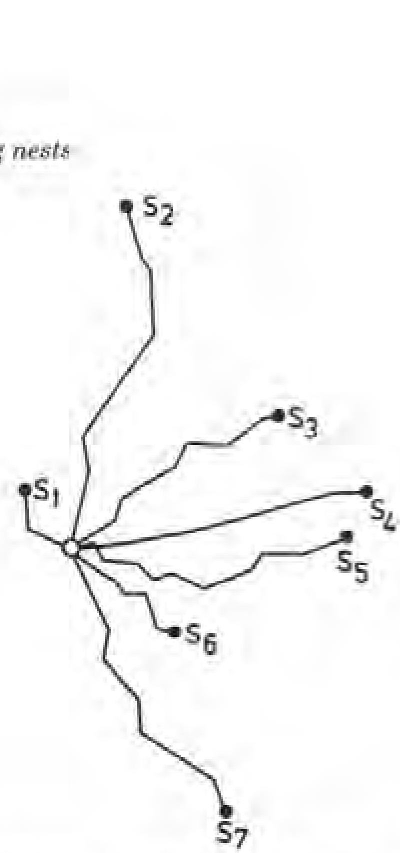


Figure 8.3a Routes taken by the same greater honeyguide to a honey bee nest when it started to 'guide' from 7 different points, S1 to S7 (Isack & Reyer, 1989).

Searches for honey bee nests by Boran honey hunters were monitored in an area with which the men were unfamiliar. The average time to find a nest was 3.2 hours with the aid of a honeyguide, or 8.9 hours without it, and there were additional searches when no nest was found. So the honey hunter benefited greatly, and the bird did too: of 186 nests located, 96% were inaccessible to it until the honey hunter opened the nest up to get at the combs.

The direction in which the bird flew indicated roughly the *direction* of the nest it had found, and Figure 8.3a shows the result of an experiment that demonstrated this. According to the Boran, the bird indicated the *distance* as follows. If the nest was close by, the bird disappeared for only a short period after its first encounter with the hunter; it did not fly far

before perching again to wait for him, and it chose a low perch. If the nest was farther away the bird disappeared for longer, flew further before perching again, and chose a higher perch. Measurements confirmed these observations by the Boran.

8.4 Methods of reaching honey bee nests

Honey bee nests in old termite mounds or in the ground presented relatively few problems of access to honey hunters. In many areas, nests in rocks could be reached by clambering to them. If an aid was needed for reaching a nest, a temporary ladder of some type might be contrived, as in Figure 8.4a. Near the Tanzania/Rwanda/Uganda borders, Schaller (1965) was with Batwa people who saw bees flying near a small hole in a tree, $3\frac{1}{2}$ m above the ground. They immediately wedged a sapling against the trunk and climbed up to the nest; activities there are described in Section 8.5. Or a rope ladder could be made from lianas, and such ladders are shown in many rock paintings, for instance Figures 6.2a(A) and 8.1d. North of the Zambesi river in Tanzania (Hunter, 1952), the Sandawe used a climbing rope 'made from the fibre of the baobab tree ... A stone, encased in a leather jacket, is attached to one end and ... thrown over a branch ..., and the stone lowered to the ground. Grasping the doubled rope, the honey collector climbs to the branch ... [He carries the honey combs down] in his gourd flask which is fitted with shoulder straps.' Spherical stone balls have been found at various prehistoric sites, and some may perhaps be such climbing weights (or *bolas* for hunting).

Stow (1905) wrote about the San:

> In some cases, where even they found it impossible to reach the spot from below, on account of overhanging rocks, they were frequently let down by their companions, with a long leathern thong, from some projecting ledge to the level of the nest below, and here, while dangling in mid-air, they would drive in a line of apparently fragile wooden supports, and thus form a sort of narrow platform, upon which they could either sit or stand whilst they abstracted the honey from the nests.

Section 14.31 decribes more permanent equipment which might be used many times for reaching owned nests. Pygmies used lianas for making the climbing belt shown in Figure 8.4b, to reach nests more than 36 m up a tree. The belt, which had to be very strong, encircled both the man and the tree. By bracing himself with his feet against the trunk, the man momentarily loosened the belt round the tree and hitched it a little higher, then hoisted himself up 30 cm or so. The Babinga Pygmy in Figure 8.4b carried his axe over his right shoulder (Bahuchet, 1972). The film *Baka people of the rainforest* included details of a honey-hunting sequence in Cameroon, and a photograph from the film (Silcock, 1988) showed a

Figure 8.4a San honey hunter's ladder in position, probably in Northern Cape Province, South Africa. By courtesy of the Alexander McGregor Memorial Museum, Kimberley (photo: K. Marloth).

Figure 8.4b A Babinga Pygmy in Central African Republic ascending a tree to a honey bees' nest, using a climbing belt (Bahuchet, 1972)

Baka Pygmy climbing a tree in a similar way; in addition, he cut footholds in the tree with his axe, so he may have hoped to harvest again from the same nest.

The Baka sometimes felled a tree containing a nest and harvested the honey at ground level. Many other peoples hunting for honey bees and stingless bees did this – for instance the Ngandu, a Bantu people in the rain forest of Zaire (Takeda, 1990), the Kasai in Bena Dibele, south-west of the Mbuti in Zaire (Dubois & Collart, 1950), and the Ngindo in southern Tanzania (Crosse-Upcott, 1958).

8.5 Treatment of honey bee nests when honey was collected

Schaller's 1965 account of a Batwa honey hunt quoted in Section 8.4, continued:

> They lit a dry, rotten piece of wood and blew the heavy smoke into the opening. They made little progress pecking away at the bark with their spears in an attempt to enlarge the hole, and decided to return the following day. During the next attempt their spears were fitted with a chisel-like point. The chips flew as they chopped, and they were coughing and spitting in the dense smoke. One Batwa reached into the tree and hauled out the combs dripping with golden honey. They ate and ate, laughing and swatting at the bees that buzzed angrily around them. Some combs held white grubs and these were eaten too. Only the wax was spat out. The Batwa had honey all over their arms and chests, and the bees landed on their skin and stung them. Then they licked their fingers and arms and stuffed the extra honey into the small calabashes they carried.

However, some honey hunters were said not to eat honey while at the nest, on the grounds that bees might then sting their lips or mouth. It is not clear whether the Batwa left any of the nest intact.

The Hadza, nomadic hunter-gatherers in Tanzania, attempted no systematic hunting of any sort; they did not feel obliged to reconstitute an opened-up nest cavity, and did not do so unless it was very easy (Woodburn, 1968). On the other hand in north Zululand a Tonga was seen to block up the enlargement he had made to a flight hole (Guy, 1972).

Honey combs taken from a nest were put into some suitable container the honey hunter carried with him, which might be a basket or barrel (Figure 8.5a), gourd or bag; Figure 8.5b shows a honey bag made from a cow's stomach. Honey bags appear in some rock paintings, for instance Figure 7.1a.

Figure 8.5a Bark basket and barrel for honey combs, Babinga Pygmies (Bahuchet, 1972)

Figure 8.5b Honey bag (*rungu*) sewn from a cow's stomach, Wakamba people, Machakos district, Kenya, 1973 (photo: J. Corner).

In addition to a very strong rope used when climbing a tree, a honey hunter might use a separate rope to lower a container of combs to the ground. People who congregated below the nest – as in the rock painting in Figure 7.1b – then received the full container lowered on the rope; they may already have relished pieces of comb that fell separately. It is interesting to compare Deschodt's description of behaviour in chimpanzees (Section 5.4).

In many parts of Africa the combs were carried home in the container used for collecting them, for instance Cameroon, Kenya, Tanzania, Zambia, and probably also Mali (Paterson, 1989).

8.6 Use of smoke and other bee pacifiers

In honey hunting at its most primitive – or most degraded – level, the bees were not only smoked, but deliberately burned and killed. Examples are given in many publications cited in Table 8.1B, but the practice was less common before tribal custom was disrupted during the 1900s, and may have been rather rare. Smoke was widely used, as by the Batwa (Section 8.5), but only one rock painting is known which shows it (Figure 8.6a). This is in a rock shelter in the Matopos National Park in southern Zimbabwe, which was used by the San and much earlier peoples, from perhaps 8000 BC. Peter Genge from the National Museum tried to take me to see it in 1984, but armed fighters were using the rock ledge as a lookout post; the painting was, however, undamaged. In Figure 53.2a, also from Zimbabwe, the representation of the nest is very similar and in addition shows many bees streaming out of the nest entrance.

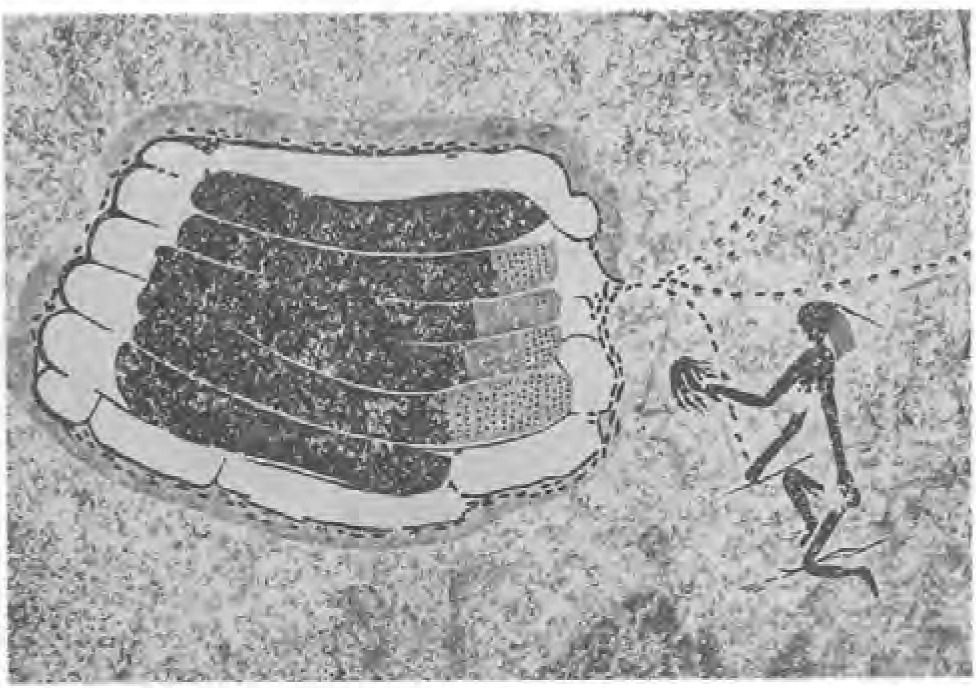


Figure 8.6a Rock painting showing a honey hunter using smoke, Toghwana Dam, Zimbabwe (Register ZW-001, copy by H. Pager, 1973).

Table 8.6A

Some plant materials containing an active substance whose smoke was used to pacify or repel the honey bee *Apis mellifera*

Plant	*Uses, effects*	*Region (Reference)*
Fungi		
*Langermannia gigantea**, giant puffball	narcotic, or toxic at higher concentrations	Europe (Gerard, 1597); on *A. m. unicolor* in Madagascar (Sirera, 1953)
Langermannia wahlbergi	narcotic	Tanzania (Wood, 1983; Mollel, 1987)
Euphorbiaceae		
Spirostachys africana	narcotic	Tanzania (Brenzinger, 1987)
Manihot utilissima, cassava	'tranquillizer'	Zimbabwe (Mukwaira, 1977)
Leguminosae		
Voandzeria subterranea	'tranquillizer'	Zimbabwe "
Verbenaceae		
Vitex payos	'tranquillizer'	Zimbabwe "

* = *Calvatia gigantea*, formerly *Lycoperdon giganteum*, discussed in Section 34.4.

In many countries, a smoker was carefully made from a bundle of selected vegetation, and many authors listed in Table 8.1B described how the smoke was used. In the Ituri Forest in Zaire, Mbuti pygmies made a 'smoking tube' from leaves of Maranthaceae plants (Ichikawa, 1981). When nests were difficult to reach, the smoker had to be effective all the time the man was working, as he could not return to ground level to renew it.

In some areas, the fuel used for smoking bees incorporated a plant containing an active substance which stupefied (narcotized) the bees so that they were inert while the honey was taken; at higher concentrations the substance might kill the bees. Table 8.6A lists some of these plants, most of them native to Africa, and Table 8.6B lists plant materials reported to pacify or repel bees, without the use of smoke. It has not been established how long any of them have been used, or how widely, and it is likely that others are also effective. Extracts from other plants were tested experimentally for their repellency to temperate-zone *A. mellifera* (Harpaz & Lensky, 1959; Attri & Singh, 1977).

In the forests of North Bandundu, Zaire, the Nkundu and Ntombe Bantu peoples were rather knowledgeable about honey hunting. They rubbed the hands and body with leaves of 'sake' (*Caloncoba wabewesii*) to prevent bees stinging, and could then harvest honey by daylight in such a way that the colonies survived.

A colony might be killed to get its honey by blocking up the flight entrance so that the bees suffocated. This took several days if mud was used, but crushed leaves of manioc (cassava) acted more quickly, probably because hydrocyanic acid was liberated (Svensson, 1990).

Daylight was needed for locating nests, but night was sometimes chosen for climbing up to them and collecting honey combs, especially if the bees had the reputation of being 'fierce'. In Ghana (Adjare, 1989) a moonlight night was chosen, and in Nigeria a night when the moon was waning (Mutsaers, 1989a). A honey hunter working on a dark night, when fewest bees would fly, needed a light to work by, and made a torch from a slimmer, tighter bundle of drier vegetation than the smoker. In daylight, morning or late afternoon was preferred, for instance in Swaziland, because many bees were then away foraging (Bechtel, 1989).

8.7 Treatment of the harvest from the nest

Elsewhere I have used the term 'whole-food harvesting' (Crane, 1990a) to describe the use of everything in or on the combs taken from a nest: honey, pollen, brood, propolis, brood food including royal jelly, and the comb wax. Often honey hunters and their families ate comb containing the perishable components (pollen, brood and brood food) straight away, as a special treat or feast. Brood and brood food were valued for their nourishment, and in certain areas of the Ivory Coast any royal jelly in queen cells was given to old people (Borneck, 1976). In Zambia, unsealed brood was a delicacy, but sealed brood was not eaten (Clauss, 1988).

Some honey hunters, for instance in Malawi, might start to eat the honey immediately after harvesting, discarding the wax and taking little or no honey home (Klinger, 1989). Mbuti Pygmies in the Ituri forest, Zaire, collected honey from both honey bees and stingless bees, and got quite large amounts

Table 8.6B

Some plant parts and extracts used to pacify or repel the honey bee *Apis mellifera*

Plant materials used for smoking *A. mellifera* are in Table 8.6A, and repellents for *A. dorsata* and *A. cerana* in Table 15.2A.

Plant	*Uses, effects*	*Region (Reference)*
	Tropical *Apis mellifera*	
Aristolochiaceae		
Aristolochia sp.	paste made from juice of crushed leaves, mixed with sticky pulp of *Amomum* [or *Aframomum*?] leaves, was spread thickly over face and hands	Gabon (Coon, 1972)
Canellaceae		
Warburgia[1] *longimanii*	used as repellent	Tanzania (Kawa, 1982)
Euphorbiaceae		
Manihot esculenta, cassava	leaves occasionally rubbed on body	Malawi (Klinger, 1989)
unnamed, in limestone crevices	sap quickly pacifies *A. m. unicolor*	Madagascar (Sirera, 1953)
Flacourtiaceae		
Coloncoba wabewesii	leaves rubbed over hands and body	Bandunda, Zaire (Svensson, 1990)
Labiatae		
Hoslundia decumbens Benth.	garlands worn round neck and head prevented stinging	Mozambique (Crisp, 1939)
Passifloraceae		
Adenia (Modecca) cissampeloides (Planch. ex Hook.) Harms	crushed stalks were placed near hive entrance; after 3 min 'the bees appear to be dead, but 92% recover and fly normally 30 min later'	Ghana (Adjare, 1987; Yeboah-Gyan & Agyemang, 1989)
Verbenaceae		
Lippia javanica (Burm.f.) Spreng.	used as repellent	Swaziland (Bechtel, 1989)
	European *Apis mellifera*	
Gramineae		
Cymbopogon nardus Rendle (= *Andropogon nardus* L.) and spp.,[2] lemon grass	used for 'quietening' bees	widely reported
Labiatae		
Melissa officinalis L.,[3] balm native to Europe and Mediterranean	'rubbing the hands with the leaves is claimed to, and probably does, help in preventing stings' (Howes, 1979)	widely reported
Malpighaceae		
Bunchosia nitida (Art.) DC	fresh leaves rubbed on face and arms deterred bees from stinging	Caribbean (Crane, 1988)

[1] A small family of aromatic trees; *longimanii* could not be traced at Kew. In Venda, bark from *W. salutaris* was said to be placed in hives to make the bees aggressive and thus to deter robbers (Netshiungani, 1981).

[2] Leaves are a source of citronella oil which contains citral; also used for attracting swarms to bait hives.

[3] Oil from leaves contains 63% citral, and some geraniol and nerol; also used as in [2] above.

in 12 days (Section 8.13). Ichikawa (1981) calculated the average consumption during a hunting trip as 0.6 kg honey per man per day, plus pollen, brood and brood food, providing about 1900 Kcal. But to the Mbuti, honey was above all a food to be shared with others; its distribution was used to smooth social relationships, and it functioned as the medium by which these were regulated.

In most of tropical Africa, men, women and children might eat honey, although men – the hunters – usually controlled its distribution as they did that of meat, and probably consumed most of it. Honey was also used in medicines, and its main use, except among Muslims to whom alcohol was forbidden, was the production of alcoholic drinks by fermentation in water (Section 48.4); Figure 48.4a shows the areas where this was done.

8.8 Bee hunting in Madagascar

Madagascar has a gentler race of bees, *A. m. unicolor*. Colonies occupied nests in both trees and rocks, and in some areas these were hunted to obtain bees for sale. Fert (1985) described an expedition into a forest on the east coast, with a honey hunter who located

nests by following the bees' droppings (Section 8.2). The hunter smoked the nest, and then put his hand in and withdrew it covered with bees, which were shaken into a basket of rice straw. The operation was continued until the queen was spotted; she was caught and put into a bamboo cage which was fixed inside the basket. When all the bees had gone in (1 or 2 kg), the basket was sewn up and the honey and brood combs were transferred from the nest to another container. The basket of bees with the caged queen was sold in the local market – along with several hundred other such – to individuals who could keep the bees in a pot or box in their garden. Honey combs were taken to the main town, to sell for making *toaka*, the local alcoholic drink.

8.9 Hunting for honey of stingless bees

Nests of stingless bees were also hunted in many countries of tropical Africa (Table 8.1B), although in general they yielded less honey than honey bee nests, and Table 8.9A lists some of the species known to have been used. Many African peoples had an intimate knowledge of the different species in their area, and had a name for each; they also knew the characteristics of their individual honeys.

Table 8.9A
Stingless bees (Meliponinae) from which honey was harvested in tropical Africa

Genus	Species
Dactylurina	*staudingeri*
Lestrimelitta (Cleptotrigona)	*cubiceps**
Meliponula	*bocandei**
Trigona	*denoiti*
	madecassa
Trigona (Apotrigona)	*senegalensis*
Trigona (Axestotrigona)	*ferruginea*
	*erythra togoensis**
	simpsoni
Trigona (Hypotrigona)	*araujoi*
	braunsi
	occidentalis
	*gribodoi**
	ruspolii
Trigona (Meliplebeia)	*beccarii*
Trigona (Partamona)	?

*Also kept in hives (Table 30.1A).

The finding, reaching, and harvesting of nests of stingless bees by honey hunters is poorly documented, but Ichikawa (1981) reported on the Mbuti in Zaire. Two species common in Southern Africa and some neighbouring regions were studied in South Africa by Fletcher and Crewe (1981) and in Botswana by Nkomo (1989). Workers of *Trigona denoiti*, often the most common species, are about half the size of *A. mellifera* workers. The nest is a roughly spherical chamber 60-100 cm deep in the ground, which may be about twice the size of a football; it is lined with a layer 1-2.5 mm thick of batumen, a mixture of propolis and secreted beeswax. The entrance from the surface is likely to be camouflaged beneath a clump of vegetation and is very difficult to find, so that honey hunters probably detected only 30% of them. Bees reach the nest through a meandering batumen-lined tunnel about 10 mm in diameter and more than 60 cm long, and to follow the course of this tunnel a honey hunter used a probe made from a grass stalk or a thin flexible whip from a suitable bush.

The bees store pollen and honey (whose water content is higher than that of *A. mellifera*) in separate round cerumen 'pots' which are sealed and join on to each other. The bees' defence lies in the near-perfect camouflage of their nest entrance, and the depth at which the nest is built – often in an old hard termite nest – together with their strong odour when disturbed; the bees bite, but very ineffectually.

The other common stingless bee is *Trigona (Hypotrigona) gribodoi*, similar in size to *T. denoiti*. Nests are built in tree cavities, and are also very difficult to find. Honey from this bee was part of the diet and medicine of nomadic populations in Somalia (Tremblay & Halane, 1993). In southern Madagascar, nests of *Trigona madecassa* in hollow trees were often hunted for their honey, which was much prized (Chandler, 1975a).

In Tanzania, honey from *Trigona (Meliplebeia) beccarii* was said to be fatally toxic to humans and to fowls 'unless the edible liquid-element is properly separated from the rest' (Crosse-Upcott, 1958). The toxic substance is more likely to be derived from a local plant than from the bees themselves.

9

Honey Hunting in Temperate-Zone Europe

9.1 The circumstances of honey hunting

Beekeeping started early in much of Europe north of the Mediterranean countries, but honey hunting continued long afterwards in many areas. So when honey or beeswax is referred to as a material used, traded or bartered, it is not always clear whether it was obtained by hunting nests or from hives.

Apis mellifera is the only species of honey bee native to Europe. The important vegetation belt for honey hunting was that of cool temperate deciduous (broad-leaved) forests shown in Figure 9.1a; it extended from about 35°N to 50°N and some areas farther north. The region is characterized by an annual rainfall of 750-1500 mm fairly evenly distributed through the year, and moderate summer temperatures but cold winters. Deciduous trees shed their leaves before winter, and their buds remain dormant until air temperatures rise again to 6°, so in spring the herb and shrub layers below the trees break bud and flower before the trees come into leaf. Trees, shrubs and herbs all provide forage for honey bees, and the trees – especially older oaks – provide cavities for nest sites, and a sheltered environment. Wild colonies could not survive the long cold winters in the far north (Section 9.5).

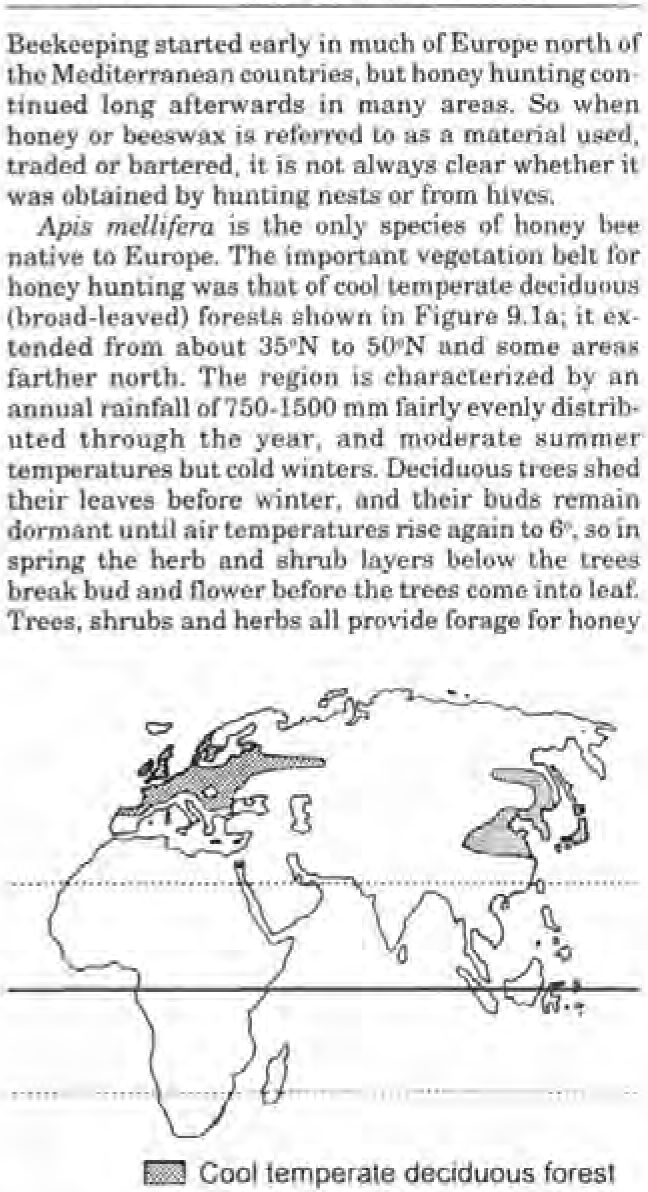


Figure 9.1a Distribution of cool temperate deciduous forests in the Old World (based on Robinson, 1972). Limes, *Tilia* spp., were of major importance in slightly more extended areas (Avetisyan, 1978).

In European deciduous forests, nests have been found especially in the following trees:

alder	*Alnus glutinosa*	limes	*Tilia* spp.
ash	*Fraxinus excelsa*	maples	*Acer* spp.
beech	*Fagus sylvatica*	oaks	*Quercus robur*,
birches	*Betula* spp.		*Q. petraea*
elms	*Ulmus* spp.	willows	*Salix* spp.

The most important sources of honey were the limes; see Figure 9.1a. At the end of the Neolithic period, around 2000-1000 BC, the climate was mild and supported rich forest vegetation, probably including species listed above and, in more open areas, raspberries, brambles and herbaceous plants that produced nectar and pollen.

Seeley and Morse (1976) examined 21 honey bee nests in trees in a somewhat similar deciduous forest in North America, and their records and others suggest the following. A nest normally grew in size until it filled its cavity, whose capacity was commonly about 40 litres but might be only 20, or up to 100 litres or more. The flight entrance was likely to be at or near the bottom of the cavity, and only a few nests had more than one entrance. Figure 9.1b shows a 'generalized' nest in a tree, and an actual nest (which is unusual in having a sloping entrance through which rain had run into the bottom part of the cavity, not shown). In most deciduous forests, the diameter of trees and their cavities limits the width of a nest to about 30 cm, and thus the number of combs in it to 8 or 9.

Pliny (AD 23-79) was one of several early writers who commented on the large size of combs found in honey bee nests in the northern Europe. In *Naturalis historia* (XI.14.33) he referred to 'a comb ... in Germany that was 8 ft [2.5 m] long' – much longer than the combs shown in Figure 9.1b.

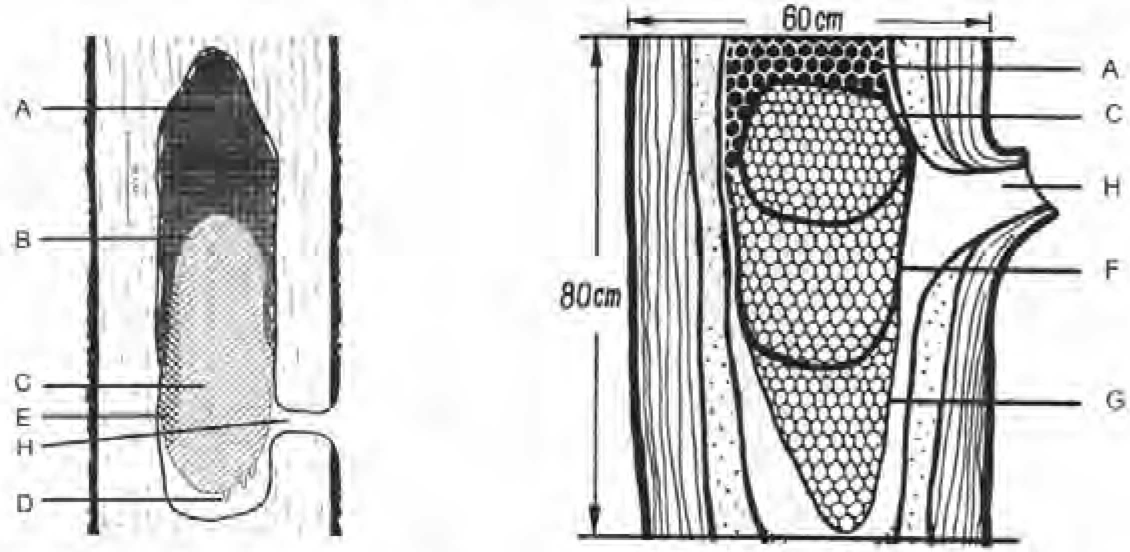


Figure 9.1b Structure of a large honey bee nest (*Apis mellifera*) in a northern deciduous forest tree. *left* Generalized nest at 42°N in New York State, USA (Seeley & Morse, 1976). *right* Actual nest at c. 50°N in Germany (Gütschow, 1952).

A stored honey B stored pollen C brood nest
D queen cells E drone comb F bee cluster
G empty comb H flight hole

9.2 Early honey hunting in eastern Europe

Written records survive from mediaeval times onwards, and Dorothy Galton quoted a number in *A thousand years of beekeeping in Russia* (1971). By the 700s-800s some of the place names in Yaroslavl, Ivanov and Gorki regions incorporated the word for honey beer in the local Meryvane language: Pure, Purekh, Pureshka. The Russians produced large amounts of honey and beeswax, and used much honey for making mead which they consumed in vast quantities: a 7-day feast at Vasil'ev in 996 was supplied with 300 wooden tubs of it. Honey and wax were also exported (Chapter 46). All must have come from natural nests until hive beekeeping began in the 1200s, but it is often impossible to tell from early records whether it had been obtained by opportunistic hunting from nests, or from nests that were owned (Section 14.4), or by tree beekeeping (Section 16.2) which was a special feature of these northern forests. Gallus, who visited Poland in the 1000s, said that the woods there were 'rich in honey'. Records from about 1100 show that ownership rights existed over bees' nests and the trees they were in (Section 14.41).

Olaus Magnus Gothus (1555) referred to Pliny's record quoted above and said that: 'even longer ones have been found in the lands of Podolia that are subject to the King of Poland.' Also, 'bees fill very great pits in the dry land with combs brimming with honey; so that monstrous bears fall into such pits and are suffocated by the quantity of honey they have devoured.' But not all the statements of Olaus Magnus are necessarily believed. Seaton (1985) said of the Ural Cossacks in the 1600s and 1700s: 'most preferred the habits of a half-nomad people, the rearing of cattle, the collection of wild honey ...'.

There are many early records of an abundance of bee forage, honey and wax in other parts of eastern Europe, and some examples in Sections 25.4 and 25.5 about traditional beekeeping may relate instead to honey hunting. Herodotus (*c.* 425 BC) commented that there were so many bees in the Danube region that it was almost impossible to travel through it without being stung.

9.3 Methods in eastern Europe

Where opportunistic honey hunting continued into the late 1900s, it has been studied in detail, and the methods used are described below. They may well have changed little over the centuries, but we know almost nothing about the chronology of their development.

A valuable source of information is the *Ethnological atlas of Yugoslavia* (1989) which contains maps by Domaćinović relating to bees. Mountain ranges in former Yugoslavia stretch from south of the Hungarian plain as far as Albania and Greece, and like the Carpathians they are a continuing stronghold of traditional practices. Domaćinović identified over a

hundred localities where nests of honey bees in rocks and cliffs, and below ground, were exploited by honey hunters in recent times. His Map 1.514 differentiates between reaching nests by ropes or ladders, using smoke, and killing the bees with fire. In some localities access was made beforehand to nests underground or in rock cavities. Honey was also harvested from colonies of bees nesting in stone walls – in Sica, in the graveyard wall where the crucifix stood.

Another valuable source is Gunda's detailed study (1968), based on written records from about 1700, and his own extensive field observations. Honey hunters in Hungarian villages belonged to only a few families; among those in Zagra village were four especially famed honey hunters. Skills were passed on from one generation of a family to the next, thus continuing older traditions based on close contact with the environment. The honey hunters were quite open about their methods, in striking contrast to poachers in the same region who worked in great secrecy, with snares and traps.

9.31 Finding nests, including the use of baits and traps for bees

More varied methods of finding bees' nests were used in the forests of eastern Europe (at 46°-48°N) than in the African tropics: some in early spring while snow was lying; others during the early summer burst of flowering; still others at the end of the late summer flowering when most of the honey hunting was done.

When the snow was melting in spring, honey hunters of some Hungarian, Slovak and Russian peoples would walk through the woods, especially any fringes facing south, looking for dead bees or other nest debris on the snow beneath a tree. Honey would be taken straight away from any nest that contained some, because the cold would prevent the bees stinging. In many parts of the Carpathians and also in Latvia, honey hunters looked for fresh tracks made in the snow by a pine marten (*Martes martes*, Mustelidae; Section 5.3). These could lead to a nest, which might be indicated by wood debris on the snow below a tree, where a marten had tried to open up a nest with its teeth and claws. Ukrainians followed bear tracks.

After flowers appeared, a common method for locating nests was to watch the direction in which bees flew away after visiting flowers. In Slovakia, honey hunters walking near flowering goat willow (*Salix caprea*) in early spring would listen for the hum of bees working the catkins. Methods used to track foraging bees back to their nest in the Carpathians were similar to those used farther south (Sections 7.5 and 8.2), except that bees were watched when collecting nectar rather than water. As in Africa, it was easiest to see the flying bees against the sun, and in Europe the sun is low in the sky for a longer part of the day. Honey hunters made an individual bee easier to see by attaching to its body a blade of grass (Ukrainians), or a small piece of paper (Estonians); this also slowed the bees down. Throughout the summer, as a honey hunter walked through the woods he would listen for the humming of bees near their nest, a sound which 'could be heard from a great distance'.

Bee baits and traps

More sophisticated methods involved catching foraging bees with an open bait, or in a bee trap baited with honey. Carpathian honey hunters used a great variety of bee traps; Gunda (1968) published maps showing locations where horn traps were in use from the 1700s, and Figure 9.3a illustrates these and other types, of which H2 – made from an elder tube – was perhaps the most like Columella's in Ancient Rome (Section 7.5). There were still others, including one made from a deer's antler. With a bee trap of the type H1, T1, R1 or S1 in Figure 9.3a, one or more bees taking honey or nectar were captured by closing the movable door within its slot. With one of the type H2 or R2, the aperture was closed with the thumb; a leaf was pressed against the egg-shaped pot T2 to close it. When the closure was in place, the bees inside could see daylight only through a grid or perforated section, and they gathered there. This enabled the operator to release bees one at a time when and where he wished, by opening the door slightly. Box traps were described in Sweden (Section 9.42), but do not seem to have been used by Ukrainians, or by Turkic-Tatar or Volga Finno-Ugrian peoples. In the Lápos valley in Transylvania a spent sunflower head was used as an auxiliary bee bait in late summer. Seeds were removed from the seed cases, which were then filled with honey, and the flower was set up in a forest clearing so that bees taking the honey could be trapped. In general, traps were most effective at this season when bees were searching for food after the end of the nectar flow. During the early 1900s, itinerant Hungarian wax merchants from southern Slovakia came each autumn to Tardona in the Bükk Mountains where they located nests by using horn traps, smoked out the bees and took the combs.

John Gedde's *The English apiary*, published in England in 1721/22, was issued in Hungarian in 1759, 1768 and 1781 together with the translator's own detailed descriptions of honey and bee hunting, including the burning of pressed honey comb to attract bees (see below). Methods of 'lining up' a bee

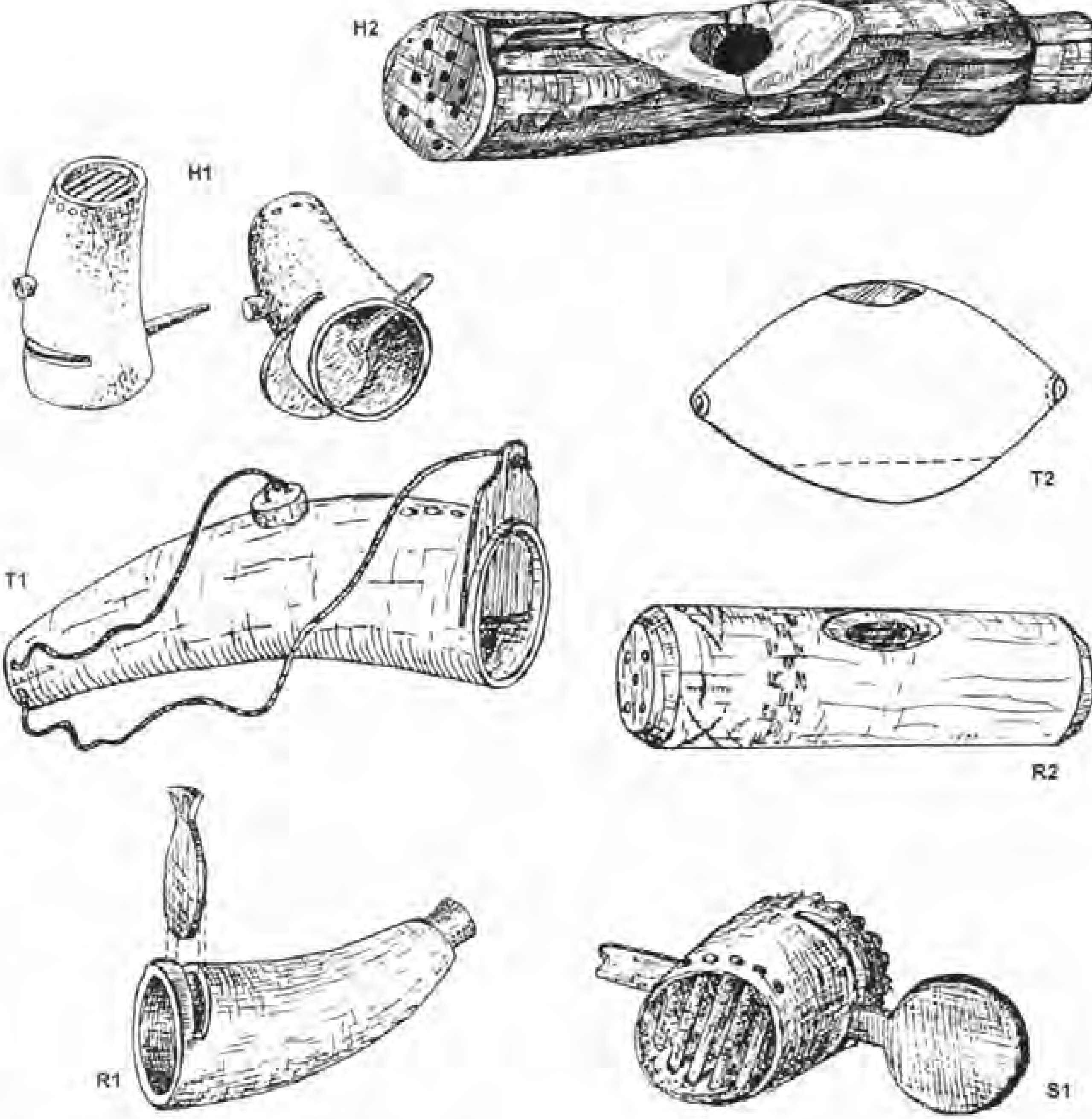


Figure 9.3a Some bee traps used in honey hunting, made of horn unless otherwise stated; not to scale (Gunda, 1968).

Hungarian, used in Hungary:
H1 Domaháza, Bükk Mountains
H2 Pusztafalu, Zemplén Mountains (older tube)

Hungarian, used in Transylvania now in Romania:
T1 Lövéte, Harghita Mountains
T2 Rév, Bihar region (unglazed pottery, egg-size)

Romanian, used in Transylvania:
R1 Zagra, Radna Mountains
R2 Cristioru de Sus, Bihar region (wooden tube)

Slovak:
S1 Hradec, Upper Nitra region.

tree from different directions by releasing bees at predetermined points were used in parts of the Carpathians, and Bulgaria, Estonia and Sweden.

In a few places in the Carpathians, urine was used as a bait. It probably attracts honey bees by its odour (see Butler, 1954) and it can also be very attractive to stingless bees (Schwarz, 1948). Methods for using a urine bait were described in detail by Hungarian authors in 1740, 1748, 1763, 1782, 1793, and 1795. In autumn, bunches of moss were spread out in a marshy place in the forest and soaked in urine. Bees flew to them 'in large numbers', and their several nests were found by following directions of flight of individual bees. Hungarians in Transylvania and Moldavia gathered large amounts of moss in sunny forest clearings in the summer, and urinated on it. Russians and Poles, as well as Hungarians, 'bathed a bee in ill-smelling human urine' and released it, to locate its nest. Gunda supposed that a bee became dazed by the urine, and so flew slowly enough to be followed.

During the intense flowering of late spring and early summer, a bait had to be very strong to compete successfully for a bee's attention. It was often a combination of hot or burning beeswax comb which attracts bees and – close to it – honey which the bees would collect, remember, and return to. The practice in the Lápos valley was fairly typical. A bowl of honey was placed in a forest clearing, on the ground or on a pole or platform, and a piece of comb put on a fire of twigs beside it. Bees on nearby flowers were captured in a horn trap baited with honey, and released near the honey bowl and smouldering wax. In response to the strong smell, the bees alighted and imbibed honey, then flew to their nest and returned together with several other bees. Their flight direction led the honey hunter to the nest.

9.32 Reaching nests

A primitive ladder might be used to reach a nest (Figure 9.3b,A) or a stick with a crook at one end (B), which a Hungarian honey hunter could lean against the tree as a ladder. A rope fastened round his waist enabled him to raise and lower a honey container tied to the other end. If working access to the nest was unsafe, he might bind himself to the trunk, or – again in the Lápos valley – construct a platform of poles before he started work at the nest. This was done mostly in early evening, when diminishing light would discourage bees from flying out. Less frequently, it was done at night.

Figure 9.3b Equipment of Hungarian honey and bee hunters (Gunda, 1968). For climbing trees: **A** ladder, Lápos valley, Romania; **B** forked stick, Ormánság region. For pacifying bees: **C** smoker, county Nógrád.

9.33 Use of smoke, and treatment of nests

When a honey hunter found a nest, he might estimate the amount of honey in it by drilling small holes through the trunk and inserting a thin stick into each in turn, as a dip-stick. Smoke was by far the most common agent used to pacify the bees while they or their honey combs were taken, or to kill them if that was the intention. Some honey hunters used a purpose-made smoker such as the pottery example in Figure 9.3b(C), which may have been copied from smokers used by beekeepers. The smoker fuel varied widely, according to location and probably also the individual's inclination. Examples included:

- *vegetable origin*: tinder, rotten wood (especially from a nut tree); wet straw; dry grass; leaves and twigs; young fir twigs, fir shavings; tobacco
- *animal origin*: cattle dung; dog hair; dry beef fat; 'foot-clout soaked in urine'.

Smoke was also applied more directly. The flight hole was sealed with clay, then the bottom of the

cavity was located by knocking the axe against the trunk to make soundings, and a new hole bored just above it. This hole might be packed with a ball of mud into which shavings had been pressed; when these had been kindled, the hole was sealed on the outside with clay. Or a tube made from a reed was inserted into the bored hole, and tobacco smoke blown through it until the bees became silent (presumed dead), and the hole was then sealed again. After a short time a larger hole was made in the trunk and the combs removed through it. In the Bükk Mountains, the flight hole itself was enlarged to get the combs out.

Alternatively sulphur was sometimes burned in the flight hole to kill the bees sealed up inside the nest, and in some areas a large hole was then cut in the trunk, as above, through which the combs were taken.

The method of harvesting from the nest depended on the time of year, and probably also on the nest's position, the estimated amounts of honey, wax and bees in it, and which of the three was the primary object of the hunting. Gunda's detailed records (1968) give no impression of any sharp distinction between various levels of operation, which extended all the way from opportunistic honey hunting to hive beekeeping. In the list below, H/W = honey/wax, B = bees; i = instant harvest, f = future harvest.

	H/W	*B*
bees killed and combs taken	i	–
some combs extracted, colony otherwise undisturbed	i, f	–
tree marked, and honey taken later in the season	f	–
combs taken, bees taken alive	i	i
the part of the tree containing the nest cut off, taken home, and used as a hive	i	i

9.34 Bee hunting

In many regions of Hungary and elsewhere, beekeepers obtained extra colonies for hives by keeping a look-out for bees in the forest and locating their nests.

In the Lápos valley, Hungarian honey hunters took both adult bees and honey combs from a natural nest, and left the tree standing. Combs were removed through a door cut in the trunk, after smoking the bees through a hole made near the bottom of the nest cavity (Section 9.33). Then a wedge-shaped hole was cut near the top of the cavity, and an upright wicker or straw skep hung with its mouth just above the hole. Further smoking at the lower hole drove the bees up and out of the upper one, whence they walked into the dark interior of the skep.

When removing a log containing a natural nest, the following method was practised in summer or winter by Hungarians, Ukrainians, White Russians and some other peoples. The exact location of the nest was determined by blocking up the flight entrance and then testing the trunk in different places by knocking it with an axe, and listening for sounds from the bees. The required part of the trunk was separated off with an axe and saw, and carried home wrapped in a piece of cloth. It was always set upright, the top or bottom being closed off with a board if necessary.

Beekeepers also watched for swarms from hives and collected them, but this seems to have been less important.

9.4 Western Europe

9.41 The general picture

Advances in honey hunting north of the Mediterranean lands seem to have been initiated in eastern Europe and carried westward from there. Levels of expertise in the west probably never attained those in the east. On the other hand hive beekeeping became important and more skilled in the west, and honey hunting declined earlier and left fewer traces. Section 9.5 considers whether or not honey bees were present in peripheral regions of western Europe – the Scandinavian peninsula and the offshore islands of Britain and Ireland – when early man first reached them.

The earliest identified product from a bees' nest in Europe is beeswax in a Neolithic settlement in Bavaria dated to 3700-3340 BC (Section 49.51). Suggestions of honey harvesting from bees' nests during the Bronze Age, perhaps c. 1500-1000 BC, have been made as a result of several finds of a collection of pollen grains from identifiable flowering plants that yield nectar. These pollen grains were usually in or near a vessel that could have held honey or a honey-based drink; see Section 48.33.

Several authors in the 400s-700s stated that in west Germanic areas nests in hollow trees and rock crevices were hunted for their honey, and from the 1300s onwards there are a great many records about tree beekeeping (Section 16.2). It is likely that in the Middle Ages honey was obtained from both natural nests and hives, since hives dated to the first few centuries AD have been excavated.

9.42 Scandinavian peninsula

The climate here was comparatively warm and dry during the Bronze Age, and honey bee colonies could survive farther north than now (Section 9.5). The earliest written evidence found which related to bees is a comment by Ansgar, the first Christian missionary to Sweden. He arrived in Birka, an island just west of Stockholm, in AD 829, and in his *Vita Ansgarii* described Sweden as 'rich in honey'. In 1220 the laws of West Gothland (*Västgötalagen*) included a section on wild colonies of bees, and honey hunting was done in subsequent centuries (Sandklef, 1937; Husberg, 1994). Olaus Magnus (1555), who had been Archbishop of Uppsala, said that if bees were in 'caves or tree holes, in which they are apt to gather, they are driven out with smoke'. A farmer who found bees in the woods might take the honey and destroy the bees, or he might remove the part of the tree containing the nest and keep it in his garden as a log hive. If a colony was found in an ordinary tree on unowned land, the finder was allowed to fell the tree to get at the nest. But if the tree was a valuable kind such as an oak, he was not permitted to damage the tree in order to take the honey or the bees (Fries, 1981). There is a record of the use of box traps (*bikap*) and cup-shaped traps (*bikärl*) by Swedish honey hunters in 1686 (Sandklef, 1937).

9.43 Britain and Ireland

After the end of the last Ice Age around 10,000 BC, plants, animals, and peoples (*Homo sapiens*) spread northwards through Europe. Also, the melted polar ice led to a rise in sea level, and Britain and Ireland – previously part of the mainland – became separated with whatever plants and animals were already present. The separation of Ireland from Britain has been dated to about 8000 BC, before Britain became separated from mainland Europe at about 5500 BC; nevertheless, Mitchell (1990) showed that plants and animals continued to cross from Britain to Ireland until at least 5500 BC.

Pollen analysis of peat deposits has identified certain plants that were present at different periods. In a paper considering the absence or presence of honey bees in Britain in prehistoric times, and its implications, Limbrey (1982) concluded that the bees probably reached Britain at or before the arrival of lime trees; pollens found at Hockham Mere, Norfolk, show that lime and hazel were both growing there about 6250 BC (Godwin, 1975). By that time hazel – but not lime – was also present at North Mains in Perthshire (Hulme & Sherriffs, 1985). In Scandinavia, the presence of hazel has been regarded as an indicator of honey bee survival (Section 9.5), and on this basis honey bees might have been present in Britain by 5500 BC, with lime as forage in the south. Meanwhile oak, hazel and willow, but not lime, were among the trees that dominated the Irish countryside: hazel and willow pollens found at Woodgrange, Co. Down, were dated to 6000 BC (Mitchell, 1990). Hazel was probably in Ireland by about 8000 BC. The earliest evidence of man in Ireland has been dated to about 7000 BC, so inhabitants could have obtained honey by hunting for nests well before the Neolithic period, which started there between 4000 and 3000 BC.

In England, Neolithic levels at Runnymede Bridge near the Thames, dated to 3000-2650 BC, contained 20 sherds with a black (charred) deposit on the inner surface. Analysis by various chromatographic techniques showed the presence of beeswax, glucose and resin on one sherd, suggesting that this pot had held honey (Needham & Evans, 1987). The deposit on a second sherd showed fructose and maltose which are sugars characteristic of some honeydew honeys, so it seems that this might also have been a honey residue. (Samples of honeydew honey from silver fir, *Abies alba*, contained 34% fructose and 9% maltose; Crane, 1990a.)

Pliny (XIV.22) is quoted as saying that 'these islanders [in Britain] consume great quantities of honey brew'. According to Welsh tradition recorded in the Middle Ages, but referring to much earlier periods, Britain was known as the isle of honey. 'The first name that this island bore, before it was taken or settled, was Myrddin's Precinct. And after it was taken and settled, *Yr Fêl Ynys* (the Isle of Honey).' Williams (1972) quoted this from Bromwich.

During the Anglo-Saxon period in England (410-1066) much honey was collected from nests in trees as well as from hives (Fraser, 1958); after 1066 all land was owned, and with it any nests of bees and their honey, which are therefore considered in Section 14.5.

There is a notable lack of information from past centuries about honey hunting in Scotland – or indeed about natural nests of bees. *Leges forestarum*, a long text from about the 1100s containing laws on hunting and grazing rights in Scottish forests, was published in Latin and English by Gilbert (1979). It contains no references to bees or honey (Kelly, 1992), so perhaps there were no honey bees in the pine forests that covered much of Scotland – through lack of bee forage, or because of long and severe winters. In 1668 John Gedde remarked that bees stored large

amounts of honey in natural nests in old oak trees in Falkland, Fife, south of the Highlands (Robertson, 1990). Robertson (1989) studied the period from 1700 onwards, and found 'little evidence relating to the eating of honey'. Most of the few later references to honey and beeswax (e.g. Walker, 1988a) come from the region between Edinburgh and Brechin, which includes Fife.

There are references to honey in Ireland in early historical times, when some of it would have been obtained by honey hunting. In the 600s, the Venerable Bede of Northumbria described Ireland as an 'island rich in milk and honey', and the Northumbrian King Aldfrith, who left Ireland in 685, said that he found there 'gold and silver; I found honey, I found wheat' (Senex, 1859). Bees, honey and mead were mentioned in a (fictitious) dialogue about an Irish hermit in the 600s; see Section 47.22.

Culdees, a monastic order in Ireland, were allowed to drink thick milk mixed with honey on Christmas and Easter Eves. A common measure used for honey (Ransome, 1937) was four times 'the full of a hen egg shell' – about 270 g.

9.44 Bee hunting

Bees were collected from natural nests for use in beekeeping in parts of Western Europe, as in other regions.

Records from legal proceedings in various parts of Luxembourg between 1459 and 1738 (Poos, 1978) show that wild colonies were much sought, and that a substantial value was placed on them in law. For instance in 1663 a colony was classed with a calf or a young partridge, which was worth twice as much as a piglet, lamb or kid. It seems that from 1459 onwards, and probably before, the bees were wanted (to populate hives, Section 27.42) rather than honey or wax, and that by the mid-1400s honey hunting had largely been superseded by hive beekeeping in Luxembourg.

9.5 The northern limit for honey bee survival

Colonies of temperate-zone *Apis mellifera* which evolved in Europe were able to survive the winter even if temperatures were too low for bees to fly, and for most plants to flower. A wild colony nests in a sheltered and insulated hollow inside a tree, and studies have shown that at the onset of winter it ceases to rear brood and no longer maintains the central part of the colony at 35°, the temperature needed for brood survival. The adult bees form themselves into a cluster whose centre is more or less hollow according to how far the air temperature drops; the bees maintain their body temperature only sufficiently to allow them to survive, with minimal movement and requiring minimal food consumption. Many individual bees die in the course of the winter; for instance in Britain about half of them by March, when the colony population is lowest.

Brood rearing restarts in January, after the days have begun to lengthen but well before temperatures are high enough for bees to fly. This early start of brood rearing is triggered by the increasing photoperiod (day length), and is a necessary part of the bees' survival strategy. By March, sufficient brood is being reared to replace the old bees that have died, and subsequently the adult population increases again.

In the natural state, the honey bee as a species survives and spreads in an area by swarming. In the swarming process a colony rears new queens, and a proportion of the workers, with a queen, fly off as a swarm. Provided they can locate a satisfactory nest site, they establish a new colony. They must then build comb, and rear sufficient new bees to store enough honey, before flowering ends, to last the colony through its first winter, which is especially critical. In woodland at 42°N in the USA, 76% of swarms that settled in tree cavities died during their first winter (Seeley, 1985). In the cool temperate zone there may be only a short window of opportunity in the course of the summer when (*a*) colonies have grown large enough to send out swarms, and (*b*) these still have a long enough period ahead in which to store sufficient honey for their winter food (Seeley & Visscher, 1985). As the latitude increases, the duration of this window becomes shorter and shorter until it finally disappears, thus setting a northern limit to the regions where honey bees as a species can survive in the wild.

Two sets of records collected in Sweden provide information about the northern limit for wild honey bee colonies in Scandinavia at different periods. First, an inventory of hives of bees was made by royal command throughout Sweden in 1751 and, since the hives were upright logs and the bees received no more management than wild colonies, the inventory may indicate where wild colonies could survive. None were recorded north of the hatched area in Figure 9.5a, the top of which corresponds roughly to the present northern limit of hazel. In places much farther north – as far as 64°N – hazel pollen from trees dated to the Bronze Age was found in peat deposits. The Bronze Age came at the end of a relatively warm period which followed the Ice Age, and there were

Figure 9.5a Northern limits of wild-nesting honey bees in Sweden, using hazel, *Corylus avellana*, as an indicator (reproduced by Hansson, 1955). *hatching:* Present limit of hazel. *black dots:* Finds of hazel pollen from the (warmer) post-glacial period which included the Bronze Age.

habitations as far north as 68°. The climate deteriorated rapidly as the Iron Age began about 500 BC (Jones, 1968). At the present time in Norway, permanent colonies are not known to live in the wild north of the Oslo region at 60°N (Hansson, 1989; also Figure 9.5a), and it has sometimes been said that honey bees are not native to Norway. However, the map in Figure 9.5a suggests that they could have reached the south-east coastal belt, including Oslo Fjord, and survived there. Remains of honey bees were found in a recent excavation in an area of dwelling houses at Gamlebyen in Oslo. They formed a considerable portion of sample 170, from a level corresponding to AD 1175-1225, and there were 'probably tens of thousands', so perhaps they belonged to a colony or a swarm (Kenward, 1988).

The end of Section 16.22 refers to northern limits in Russia.

10

Honey Hunting in Asia East of Persia

10.1 The variety of honey-storing bees in Asia

In the Asian tropics *Apis dorsata* and *A. florea* are native honey bees which nest in the open. Native cavity-nesting bees are *Apis cerana* which also live north of the tropics, and species of stingless bees (Meliponinae). *Apis mellifera* – the honey bee of Africa and Europe – is not native to southern Asia east of Persia, but European *A. mellifera* was introduced in various countries in the 1800s or early 1900s. Farther north it was also present in forests east of the Urals (Section 14.7). Nests of all these social bees were hunted for their honey.

In the last century the Revenue and Agricultural Department of India collected twenty detailed reports on bees and on honey and wax production from areas that are now in India, Pakistan, Bhutan, Bangladesh and Myanmar (India, 1883). These contain some hundreds of entries on the occurrence of different honey bees and stingless bees, colony sizes, yields of honey and wax from honey hunting, and the bees' migratory or absconding habits. Hive beekeeping was rarely reported, and most honey and wax probably came from natural nests.

In tropical regions, if *A. dorsata* was present its colonies usually stored much more honey than those of other species, and they were the chosen quarry for honey hunting, although some exceptions are mentioned later. Hive beekeeping with *A. cerana* often seemed to be late in starting in these areas (Crane, 1995), but it was done in some areas, for instance Sarawak and Kalimantan in Borneo (Vries, 1994).

In many regions, opportunistic honey hunting of the various bees developed into ownership and tending of their nests, dealt with in Section 14.7 and Chapters 15, 18 and 19.

10.2 The giant bee *Apis dorsata* at different nest sites

10.21 Nest sites and their requirements

Honey comb has probably been harvested from *Apis dorsata* in almost all regions where the bee lived (Figure 3.4a), in spite of the inaccessibility of the large nests and the bees' readiness to sting. Table 10.2A indicates the common site of the nests in regions where harvests have been obtained from them, by hunting or a more advanced method (Section 15.2, Chapter 18). *A. dorsata* does not occur in the north of Asia (Japan, Korea, Mongolia, Russia, China except the extreme south) or the west (Afghanistan, Iran, upper parts of the Indus catchment area in Pakistan, and Kashmir in India*).

The single large comb of *A. dorsata* may be 1 m to 2 m across and up to 1.5 m in height. Tens of thousands of bees cling together in 'curtains' over its surface, and the comb may contain up to 40 kg of honey or more, as well as brood. Therefore the comb must have a very strong support. The bees also need a clear area below the comb and, in certain environments, a much larger clear space around it, as shown in Figure 4.2d, for the following reasons. Any close vegetation could give climbing mammals or insects (especially ants) an access route to the open nest with its food stores. Also, in the hot part of the day workers make short mass flights, during which they regurgitate into the air a watery liquid from their honey sacs – about 10% of their body weight – and thus cool themselves (Mardan, 1987, 1989).

Nest sites satisfying these conditions occur in a limited number of places: an overhang in sheer rock faces; a strong branch high in certain tall trees, or in a lower tree in a swamp or small island and thus protected from marauders; or a high undersurface of a man-made structure such as a temple or water tower. On a sheer rock face or a high tree (Sections 10.23, 10.24), there may be a number of possible sites in close proximity, and a hundred or more nests then occur close together. Reddy (1995) reported that round Bangalore the highest numbers of nests per tree were found where bee forage was within 500 m.

*Disturbance due to recent fighting along the Pakistan-India border caused some colonies of *A. dorsata* to move to other nesting areas at higher altitudes, including the Lower Swat valley. Jehan Gir Khan saw a colony nesting in Mingora in 1975, and near Landakay and Saidu Sherif in Lower Swat in 1976. Khalid Khan saw them in Minglowat in 1988/89.

Table 10.2A

The most advanced traditional method recorded for harvesting honey and wax from *Apis dorsata* nests by different peoples

Column 2: R = on sheer rock face, S = on tree in swamp, T = on high tree
Headings to columns 3-6 indicate relevant Section in the book
Only the most advanced method referred to in each region is indicated

Region or people	*Nest sites*	*Honey hunting 10.2*	*Ownership/ harvesting rights 15.2*	*Tending 18.1*	*Rafter beekeeping 18.2*
Bangladesh:					
cultivated land	T	x			
Sundarbans	S	x			
Bhutan	R T	x			
Cambodia	T?	x?			
China:					
Tibet (Nepalese people)	R	x?	x?		
Yunnan	R	x?			
India:					
many states	T				
Andaman Islands	R? T			Andaman	
Chenchu	R		x		
Kanjar	T?	x?			
Sikkim	R	x?			
Sundarbans	S	x?			
Tamil Nadu	R T	x			
Indonesia:					
Sulawesi	T				
NE Sumatra	T		x		
S Sumatra, Lampung	T			Lampung	
Belitung Island	T			Belitung	
Timor	T		x		
Kalimantan, Kapuas R.	S				Kapuas
Laos	R T	x?			
Malaysia:					
Peninsular	T		x		
Sabah	T	x?			
Jakun	T?	x?			
Nepal:					
Gharti	R		x?		
Gurung	R		x		
Pakistan	R T	x?			
Philippines	R T	x?			
Sri Lanka: Veddas	R T		x		
Thailand	T	x?			
Vietnam:					
Cat Ba	R T			Cat Ba	
Mekong delta	S				Mekong

In swamps (10.25), trees are usually smaller and their branches less strong, and nests often occur singly.

According to Toumanoff (1940) in Vietnam, *A. dorsata* wax was of particular importance, 'being extensively used by the native industries'. An occupied nest contained much brood, and extraction of pure wax was difficult, so a comb was usually taken immediately the bees migrated away, when little or no brood was present, before insects and birds could demolish it.

10.22 Early evidence, including rock art

Rock art provides the earliest direct evidence of honey collection from *Apis dorsata*, as well as from *A. mellifera* (Section 6.2). Table 10.2B summarizes the content of twelve rock paintings showing honey collection, all within a small area south-east of Bhopal in Madhya Pradesh, central India. In one of the earliest, from Mesolithic times, 22 nests hang from the branches of a single tree (Figure 10.2a). At the

Figure 10.2a Mesolithic rock painting at Ganeshghati, near Bhopal, central India, showing 22 *Apis dorsata* nests in a tree (Register AN-02, Sharma & Ali, 1980).

Figure 10.2b Rock painting in white, Jambudwip shelter, Pachmarhi, central India, showing *Apis dorsata* honey collection using ladders and a pronged reaching-pole (Register AN-08, Gordon, 1960).

Figure 10.2c Part of a rock painting in white, Imlikhoh shelter, Pachmarhi, central India, showing a woman? holding a torch to an *Apis dorsata* nest (Register AN-11, drawing: J. Gupta). Other nests are shown nearby.

top – but not on the tree, and possibly incidental – is a figure referred to by Mathpal (1984) as a woman; at the foot is a man carrying a shield, standing between two mammals (?antelope). Figure 10.2b shows activities on a rock face, including the use of access ladders and a long reaching-pole with 3 prongs at one end. Other paintings include reaching-poles and also round-ended poles. In Figure 10.2c a person (a woman?) is holding a torch against a comb, probably to kill the bees; the gender of individuals in honey-hunting scenes is discussed in Section 53.2. Figure 10.2d shows 4 honey hunters, some carrying pots for the honey; two other paintings show honey pots, and there is a bag or basket in Figure 10.2b. Two recent rock paintings in Sri Lanka show bags for honey (Seligmann & Seligmann, 1911), but not nests or honey hunters.

The next information comes from the Chin dynasty in China. Chang Hwa (AD 265-290) described the collection of combs from *A. dorsata* nests on a rock face in the extreme south, by a man let down in a basket and hauled up again; Sections 15.22 and 5.5 quote parts of his account. *A. dorsata* beeswax was probably used for casting metal by the lost-wax method (Section 49.43), which had been practised in

Table 10.2B

Rock paintings in India that show honey collection from *Apis dorsata* nests

Column 1: Number in Register of rock art related to bees and honey hunting
Column 2: M = Mesolithic, P = Post-Mesolithic (Mathpal, 1984)
Column 4: f = female, m = male

Reg. no.	*Period*	*No. combs (nests)*	*No. persons approaching comb*	*No. ladders*	*Also shown*
Comb(s) on tree branch					
AN-01	M?	3	2m		1 comb bisected, 1 trisected; 1 man carries leafed stem/smoker
AN-02	M	22	1m + 1f		2 mammals (?antelope); *Figure 10.2a*
AN-05	M?	13?	1m		horse and rider overlaid on bee scene
AN-06	M?	6	2m		1 comb bisected, 1 trisected; 1 leafed stem/smoker
AN-07	P	8?	3m		4 combs bisected, and 1 with part cut off ready to fall
AN-12	P?	1	3m		bees on and many round a comb; brood area in centre
Comb(s) on rock face					
AN-03	P	3	4m		3 combs show stored honey, and bees below it ?on brood; men carry honey pots; *Figure 10.2d*
AN-04	M	1	4m		nest trisected; 2 round-ended poles, smoker, rope
AN-08	M	1	1m + 1f	2	bees around comb, and on its lower (brood) area; stored honey above; the woman holds a honey bag/basket, the man a pronged reaching pole; *Figure 10.2b*
AN-09	P?	1	1m	1	man holds a reaching pole, with ?spear on end; ?bag on a holding rope
AN-10	P?	0	2m	1	many flying bees; 2 men on ladder, 1 holds a reaching pole
AN-11	P	1	1f	0	bees in and around comb; woman holds torch against comb; *Figure 10.2c*

Figure 10.2d Post-Mesolithic rock painting in white, Rajat Prapat, central India, showing *Apis dorsata* nests hanging from rocks, and 4 honey hunters, some carrying a honey pot; scale 1:5 (Register AN-03, drawing: Y. Mathpal).

Figure 10.2e Copy of a 1782 design in gilt on a shutter in the palace of the brother of King Rama I, showing an *Apis dorsata* nest, and a bird – perhaps a bee-eater, *Merops viridis* – Bangkok, Thailand.

both China and north Vietnam by 500 BC (Times, 1988).

Illustrations of *A. dorsata* nests made in 1782 can be seen in Bangkok, and Figure 10.2e shows an example. Also a stone carving in Panataren temple, near Borobudor temple in Java, shows a legendary scene in which the deity Hanuman is destroying a garden, and a porcupine, birds and bees are fleeing from a tree he is breaking down.

Comparisons between honey hunting methods of different peoples, and between what has been observed closely in recent years and what is portrayed in prehistoric rock art, suggest that techniques have undergone little or no change from early prehistory to the present day.

10.23 Nests on sheer rock faces

Nests built down from an overhang on a high sheer rock face are inaccessible to mammals, and human honey hunters faced difficulties and dangers in reaching them. In a gorge in Sikkim (White, 1890), a Lepcha descended a ladder made of thin bamboo, 100-130 m long, 'with an earthen vessel containing fire on his head, and on reaching the combs put some green leaves on the fire [to make] a dense smoke'. Where there were many suitable overhangs, aggregations of nests might be built year after year, and systematic collection from such owned nests is dealt with in Section 15.22.

In Nepal in 1983, young Gurung honey hunters from Nalma in Lamjung district, who were not hereditary honey collectors, described to me how the 'comb cutter' of their group worked. He carried a torch and knife down the ladder, and then – in order to get close enough to cut the comb which was below an extended rock overhang – he had to swing himself towards and away from the nest, making the cut at the end of an inward swing. If he failed he had to continue swinging until he succeeded, and he cut the comb as near to the rock as possible. The whole comb fell into a large container below, where many villagers – including women – were gathered 'for the fun'. The atmosphere of this operation reminded me of the Mesolithic rock painting in Figure 7.1b, which shows a group of people gathered below an *A. mellifera* nest. In Tamil Nadu in the south of India, where it seems that such nests are not owned, Nath *et al.* (1994) gave details of the honey hunting.

The people of Tibet were Buddhist, and on principle did not do anything that would kill bees. Khando Chazotsang, niece of the Dalai Lama, explained (1980) that 'the majority of the people consider it as a sin to deprive the bees ... of their honey, since it took these bees a lot of labour and time to do the gathering'. But honey from rock faces was collected by Nepali people of Tibetan stock (Aufschaiter, 1954), and in 1983 a Tibetan in Patan, Nepal, told me that children took honey from the nests if they could. A honey hunter is depicted on a rock face in Bhutan, also a Buddhist country. In 1882 India apparently exported honey to Bhutan (India, 1883).

10.24 Nests on high trees

Honey combs were collected from nests of *Apis dorsata* on high trees in about two-thirds of the countries listed in Table 10.2A. In China during the Yüan dynasty (1260-1368) it was done without climbing the trees. Chen Chuan Chi wrote (Kellogg, 1968):

> Where the nests are in high trees that cannot be climbed, the people use long poles to pierce the nests and collect the dripping honey in a vessel. Sometimes a nest may be undisturbed for two or four years and the honey stored in the cells is still good.

However, a nest up a tree was easier to reach than one on a high rock face. Steps could be cut in the trunk, or pegs fixed to it. Sometimes cross-bars were attached (Figure 15.2g), or a separate rattan/bamboo ladder was constructed (Mardan, 1989; Schmidt *et al.*, 1985).

Many of the richest areas for *A. dorsata* were in tropical forests, where trees provided both nest sites and forage. In 1869 Alfred Wallace described in detail how nests were reached, and combs harvested, in Timor. Like many others later, he noted that the bees chose high trees that were 'straight and smooth-barked, and without a branch' for the first 20-25 m from the ground. The honey hunter 'walked' up the trunk with the aid of a rope that encircled it, carrying a torch to smoke the bees. 'Stretching himself along the limb, he crept towards the nearest comb and swung the torch just under it. The moment the torch touched it, its colour changed in a most curious manner from black to white, the myriads of bees that had covered it flying off and forming a dense cloud above and around.'

In the forests of peninsular Malaysia opportunistic honey hunters (*camuk*) usually worked alone or in pairs by daylight, in more accessible parts of secondary jungle and in cultivated areas (see Section 15.23). On Cat Ba island in northern Vietnam – where there was usually only one nest on a tree, not more than 30 m above ground – I was told that nests were found by observing the flight of returning foragers. The height of the nest was judged by the angle at which these bees rose when returning. In Laos, a honey hunter on a tree who saw a monkey, rat, squirrel or lizard passing between him and the trunk believed that he would certainly fall – unless someone immediately fixed a peg in a root at the place where the animal disappeared (Seguin, 1975).

One of the few specific references to Cambodia is a description by Dufour (1902/03) of a honey hunter making his way up a high tree to reach a nest, carrying a mallet and a basket of bamboo pegs. He knocked in one peg, then stood on it to insert the next one up, and so on. The pegs were so securely fixed 'that even an elephant could not pull them out'.

The Kanjar who lived in forests of the Ganges basin near Lucknow in India were symbiotic with neighbouring farmers, like Pygmies in tropical Africa; they may have used similar methods. Honey collection by the Chenchu (or Chechu) is referred to in Section 15.22 (*Peninsular India*). A report in 1694 said: 'Their common food is honey, the roots of trees, plants, and the flesh of animals caught in hunting' (Fürer-Haimendorf, 1943).

Soman and Kshirsagar (1991) compared current methods in Uttar Pradesh, Karnataka and Maharashtra.

10.25 Nests on trees in swamps

In a few swampy forests in tropical Asia, trees provided much nectar and pollen in the flowering season, and also suitable strong branches for nest sites which were near the ground but nevertheless well protected from mammals by the terrain. One such area well known for opportunistic honey hunting was the Sundarbans forest in the Ganges delta, part of which is now in India and part in Bangladesh (Figure 15.1a,B). Two others, in Kalimantan and Vietnam, were notable for traditional beekeeping with *A. dorsata* (Section 18.2). In all three, the land was broken up by many water courses, and often the only access was by boat.

In the Sundarbans, nests were sought afresh each season (for India, Chakrabarti & Chaudhuri, 1972; Busquet, 1984; for Bangladesh, Svensson, 1990). The men worked in groups which always comprised an uneven number, often 7 or 9. The honey-collecting season lasted from March until July; in March each group hired a boat in which to carry bamboo baskets and large jars for the honey, and the men's stores. One member remained with the boat every day while the others, who kept in touch with each other by bird calls, went on foot to hunt for nests. In India trees grew up to 5-10 m, but most nests were only a few metres above ground or water level; some were even lower, and yielded less honey. In Bangladesh trees seemed to be taller, and some had many nests. The men usually cut off the whole comb, and when their baskets contained all that could be carried, they returned to the boat and squeezed the honey into jars and shaped the wax into balls. The Bangladesh State Forest in the Sundarbans is now a 'closed' area, and honey hunters may not stay overnight except in their boats. They must pay tax on honey taken out, and records of amounts – which are considered reliable – are 177 tonnes a year in the early 1970s, and somewhat more subsequently. In Indian Sundarbans the amount decreased to one-fifth between 1950 and 1970, and was only 20 tonnes in the early 1970s (Mulder, 1990).

The submerged forest in Vietnam is in U Minh in

the Mekong delta (Figure 15.1a,K). *A. dorsata* beekeepers there (Section 18.2) also hunted for natural nests built from branches of trees (Crane *et al.*, 1993a). In 1989 they used methods rather similar to those in other regions where the nests were near the ground. A watch was kept on bees collecting water, because during a honey flow *A. dorsata* needs much of it to cool the nest. A honey hunter could work out the location of a nest from the speed and direction of the bees returning to it. Also, mass cooling flights from a nest during the midday heat (Section 10.21) created a characteristic noise which enabled the nest to be located quite closely.

10.26 Sites for clustering without comb

Colonies of *A. dorsata* may be able to survive a period in one of their annual migratory areas even if there is a food dearth, by clustering on a support without building comb. The bees presumably get enough nectar for survival by foraging, and store it in their honey sacs (Crane *et al.*, 1993a). But although adult bees can survive, temperatures and/or food resources are inadequate for wax production, comb building and brood rearing. In Kaski District, Nepal, a number of colonies of *A. laboriosa* were found during the cold winter, clustering on a rock face at 1200 m; in spring they remained at the same sites, but then built comb and reared brood (Underwood, 1986). In Vietnam I was told that clusters remained for 3 months without comb, in coastal mangrove forests of the Mekong delta in the south and on Cat Ba island in the north. On the island, I was shown a clustering site on a longan tree, on which the bees had left many spots of wax (Figure 10.2f). Pham Hong Thai reported a similar cluster about 2.5 m above ground on a tree in Phu Quoc island off the west coast of Vietnam. Perhaps some of the areas also supported brood rearing in past times, and the absence of comb building was a later adaptation to a reduction in food resources.

Such clusters did not offer honey hunters a harvest of honey or wax, but a passage by Robert Knox in 1681 suggests that the Vedda in Sri Lanka may have harvested the bees to eat.

> When they meet with any swarm of Bees hanging on any Tree, they will hold Torches under to make them drop: and so catch them and carry them home. Which they boyl and eat, and esteem excellent food.

10.3 Cavity-nesting *Apis cerana*

10.31 Honey hunting

In regions where *Apis dorsata* nests were present, honey hunters usually paid little attention to the smaller nests of *A. cerana*. For example, in the part of Malaysia where hunting or collecting from *A. dorsata* nests was well developed, there was no honey hunting from nests of *A. cerana* (Mardan, 1989). No rock paintings of *A. cerana* honey hunting are

Figure 10.2f *Apis dorsata* clustering site, recently vacated, on a longan tree in Cat Ba island, Vietnam (photo: E. Crane). The small white points below the white ruler are spots of wax, which extended along 20-30 cm on the nearly horizontal branch.

known, and the earliest – indirect – information usually comes from reference to the use of honey or wax. Records below are from Korea, China (see Appendix 1), Japan, Vietnam, Sri Lanka, India and Afghanistan, but honey from *A. cerana* nests was doubtless also obtained elsewhere.

The first known reference to hunting nests for their honey, dated to AD 300s, is from Korea where *A. cerana* was the only honey bee. 'Wood honey' was gathered from old tree trunks where bees' nests were found, and 'stone honey' from nests between large rocks (Sang-Kun Lee, 1981). In north China beeswax was used for lost-wax metal casting by 500 BC (Section 49.43), and this wax would have come from *A. cerana* unless it was imported from *A. dorsata* nests in the south. In China, as in Korea, honey was differentiated according to where it was collected; during the Yüan dynasty (1260-1368), Chen Chuan Chi wrote: 'Some honey is made on the rocky cliffs and some in the ground. In the north the ground is dry, hence much ground honey is produced. In the southern regions, where the ground is moist, bees make their nests in the trees.' Ground honey in the north must have been from *A. cerana*, and probably the tree honey in the south. Kellogg (1968) quoted from an edition of *Erh ya* (1700s or earlier):

> The dry soil of the north affords good nesting places for the bees, therefore honey is found in the ground and is called 'ground honey'. In the south the soil is damp, therefore the bees make their nests in wood, and the honey is called 'wood honey'. In Szechwan Province there is still another kind of honey, the 'bamboo honey' made by bees nesting in the bamboo trees.

I know of no similar early reference to honey hunting in Japan, but 'contributions' of honey were made to the Imperial Palace in the 900s; these probably came from log hives, although some might have been from natural nests.

In Vietnam, some descriptions of honey hunting seem to refer to *A. cerana*. Bissachère (1812) said it was done in forests where there were many bees, and also in cultivated plains. The honey hunters followed 'traditional methods of killing the bees', taking honey and brood comb and eating all together as a great delicacy. According to Vallette (1922), two honey hunters would go together when a nest was discovered in a tree; one of them climbed the tree carrying a torch, broke into the nest, and let down a basket of comb on a rope to his companion. Fougères (1902) described the same method in Cambodia. Honey was collected from *A. cerana* nests in the forest by mountain tribes such as Thô, Mèo and Man (Toumanoff & Nanta, 1933).

Robert Knox, who was kept a prisoner in Sri Lanka, wrote about *A. cerana* in 1681:

> [Bees] build in hollow trees, or hollow holes in the ground ... into which holes the men blow with their mouths, and Bees presently fly out. And then they put in their hands, and pull out the Combs, which they put in Pots or vessels, and carry away. They are not afraid of their stinging in the least, nor do they arm themselves with any cloths against them.

Sri Lanka (Figure 15.1a,F) was the home of the Vedda, an aboriginal people to whom honey was very important. Reports from the early 1900s, referred to in Section 15.22, show that *A. cerana* built its nests in rock clefts and ant hills as well as in hollow trees. It was 'the sweetest bee of all' to the Vedda, who were adept at finding nests by listening for the hum of the bees. They sang about three legendary brothers who went honey hunting, starting with the euphonious phrase *Thomba, thomba, gomba me-na-na*. When a Vedda located a nest in a tree he climbed up to it, and blew into the entrance hole to drive the bees away. Then he enlarged the hole with his axe, and took out combs with his hand, eating them whole, where he was, and throwing some down to his companions below (Spittel, 1924).

The Chenchu in south India located a nest by watching for bees' droppings on leaves, or by noting both the direction in which laden bees flew and the angle their initial flight made with the ground. When the nest was found, a Chenchu 'will put in his hand when he has smoked out the bees, and extract the comb in pieces' (Fürer-Haimendorf, 1943).

There are brief references from a number of countries to the collection of combs from *A. cerana* nests in tree trunks or old termite mounds, usually after smoking and killing the bees, for instance Sri Lanka; many parts of Indonesia; the Philippines; Laos, where some nests were built in ancient tombs; Vietnam, where 'tigers add to the perils' (G.-C., 1933), and honey hunters of the Moi people in the north climbed up to 30 m above ground to take nests (Poilane, 1926). In Indochina (Vietnam, Cambodia and Laos), *A. cerana* honey was much sought by some peoples because of the bee's docility; in Laos the brood was also eaten – also wasp brood and adults (Khatri, 1990a). In Java, honey and wax were used as a deterrent against smallpox (Ossenbruggen, 1916).

Little information was found on hunting for nests

of *A. cerana* in western parts of Asia, but Kloft and Kloft (1971) cited one example in the high Pech valley NNE of Jalalabad in Afghanistan, at about 2000 m.

Early exploitations of honey bees in northern Asia east of the Urals are referred to in Section 14.7.

10.32 Bee hunting

Judging from the much more extensive evidence for *A. mellifera*, hunting *A. cerana* bees to use in hive beekeeping could have coexisted with honey hunting in many areas, especially where there was no other honey bee: Korea, Japan and most of China in the east and, in the west, Afghanistan and valleys of the upper Indus basin in Pakistan and India; see Figure 3.2a and Table 29.7A. Absconding by *A. cerana* colonies is less common in these regions than in the tropics.

The earliest reference found is in a Chinese text by the Minister for Viêt, dated to the AD 700s, which describes both bee hunting and beekeeping in north Vietnam (Faraut, 1909b).* Bees were collected from nests in tree trunks and rock crevices, and put in baskets or specially made boxes. The practice has probably continued, since it is still carried out, for example on Cat Ba island in Vietnam. Nests were found by searching for the bees' droppings on leaves (which could be distinguished from *A. dorsata* droppings), or by noting the direction in which laden foragers flew and the angle at which they rose from the forage. Most nests were in rocks, but were accessible enough for combs to be taken out. The work was done in the evening, when most of the bees had returned. Having checked that the queen was with the bees, the beekeeper put them in a net or bag, without caging the queen. He collected the honey combs at the same time, and also took some brood comb from the nest to put in the hive with the bees, unless the way home would be too long or difficult in the dark.

A. cerana bees were hunted elsewhere to put in hives, for instance by Annamese in Vietnam (Fougères, 1902) and in Thailand (Akratanakul, 1976). In Bangladesh, development projects using *A. cerana* in hives routinely collected (and paid for) wild colonies every year since the 1970s, because previously hived colonies did not survive the monsoon season. Especially in the late 1980s, this practice greatly depleted the number of colonies nesting in the wild.

*Appendix 1 records a Chinese medical application of honey bees in the 700s: whether or not they were attracted to a sample of a patient's urine placed near a nest was used in the diagnosis of diabetes.

10.4 The dwarf bee *Apis florea*

Apis florea is distributed widely in lowland tropical Asia and parts of the Arabian peninsula, at altitudes below 500 m (Figure 3.4a). In certain hot dry areas it was either the only honey bee capable of surviving in the wild, or by far the commonest one. Its colony is very small, and thus sensitive to temperature changes. In a hot climate the bees may build one nest for summer in a well shaded site, and a new one for winter in a site that is warmed by the sun.

When a honey hunter found a comb, he brushed the bees off, and usually took it with the portion of the branch supporting it. (The adult bees might well resettle on a branch nearby, with their queen, and build another nest there.) The comb was sold, on its piece of branch, at any rate in Thailand (Figure 4.2a), northern Vietnam, and part of the lower Indus basin, and this may well be an ancient practice. In Thailand, *A. florea* was probably the species whose combs were most collected. It was abundant in the provinces Petchburi, Prachuab-khirikhan, Khon-kaen and Nakorn Nayok, and one man might collect a thousand or more combs a week during the summer season (Akratanakul, 1976).

A. florea – possibly aided by man – spread along the coastal belt of Persia (Iran), where nests were hunted (Mossadegh, 1993), and round the Persian Gulf as far as northern Oman. The bees still live there in the hills and mountains, where they build nests in small caves and crannies in the sides of wadis, and in trees such as *Ziziphus spina-christi*. Honey hunting in Oman was described by Dutton and Simpson (1977) and Whitcombe (1984b). Methods of locating a nest from a distance were rather similar to those described in Section 8.2 for *A. mellifera*: finding bees collecting water or nectar and watching their direction of flight from it, looking for droppings on leaves, and – when close to a nest – looking towards the sun low in the sky for shimmering wings of bees approaching the nest. Recently binoculars might be used to scan likely caves from a distance; inside a cave, unoccupied nest sites could often be identified by traces of wax on the underside of the roof. Whitcombe (1984a) included a map showing areas in Oman where *A. florea* was present, where it was the only honey bee, where all honey was obtained by hunting, and where nests were 'managed'.

In areas where *A. dorsata* or *A. cerana* also lived, the attention honey hunters paid to *A. florea* was variable. Differences might be cultural, and perhaps based on past geographical distribution of the different bees; this may have changed as a result of

climatic variations, or man's actions altering the pattern of vegetation – reducing bee forage by felling trees, or increasing it through growing certain crops. In Bangladesh recently, *A. dorsata* thrived best in the forest, *A. cerana* in farmland and *A. florea* in urban areas (Svensson, 1989). In 1989 I found that in Vietnam *A. florea* was considered hardly worth attention, presumably because much more honey could be got from *A. dorsata* and *A. cerana*. On the other hand in parts of Baluchistan – a dry area west of the lower Indus valley – the gentleness of *A. florea* and the accessibility of its single-comb nest were greatly valued, and there was reluctance to tackle either the large *A. dorsata* comb or the multiple-comb nest of *A. cerana* inside a cavity (Crane, 1989b). It may be that a local tradition of harvesting honey from *A. dorsata* was lacking because these bees have occupied the area only recently.

Much *A. florea* honey was collected in Kutch, just inside India south of the mouth of the Indus. According to a 1994 report by Chaudhary *et al.*, nests 'at a very low level' were abundant during March-April and October-November. Villagers smoked the bees away and squeezed the honey out of the combs, producing 250-300 tonnes of honey a year in all. The maximum yield per colony is quoted as 4 kg, so the harvest might have come from around 70,000 nests.

A. florea honey was highly regarded in many countries for its flavour, and was also used for medicinal purposes. It was usually the most expensive honey of all, but in north-east Thailand where it was very plentiful, it fetched a lower price than *A. dorsata* honey.

10.5 Stingless bees

In Asia these bees live in much of the tropics (Figure 3.2a). Their nests give less honey and wax than most honey bee nests, and they have been less exploited by man. The earliest reference found is from the Molucca islands, which stretch from Sulawesi (Celebes) to New Guinea; these islands are east of the Wallace line, and were without native *A. cerana*. Pigafetta (1521, published 1969) documented Magellan's first circumnavigation of the world, and he wrote: 'In all those islands of Molucca are found ginger, sago, ... honey from bees as small as ants, who make their honey in trees.' Direct reports of probable hunting for nests of stingless bees in Indonesia were published by Cattenburch (1864), Hoekman (1929a) and Vries (1988). In Vietnam in 1989 I heard that nests of a *Trigona* species were hunted for their honey in parts of Annam. In the Andaman Islands, during epidemics the negrito people erected poles in front of their houses, striped with black wax whose smell could chase away the demons (Ossenbruggen, 1916).

In 1859 J.R. Tennent reported that most of the honey and wax collected by 'the uncivilized Veddas' in the highland forests of Sri Lanka was from bees that possess no sting (Gerstäcker, 1864). The Vedda brought the wax down to the plains, where they exchanged it for arrowheads and clothing. Seligmann and Seligmann (1911) were given honey by the Vedda, from 'small stingless bees [which] supply a considerable quantity', although in a scarce period the little honey available is 'frequently full of grubs'.

11

Honey Hunting in the Americas and Oceania: Stingless Bees

11.1 The peoples, regions and bees concerned

The American and Australian continents became separated from the Old World before honey bees (*Apis*) evolved there, and they were without honey bees. On the other hand stingless bees existed earlier (Table 2.1A), before the continents separated, and are present in the tropics of America, Oceania, Africa and Asia (Figure 3.2a).

The first people to reach the Americas came from the extreme north-east of Asia, and their descendants collected honey, wax and brood from nests of different species of stingless bees throughout the American tropics. Rock paintings of stingless bee nests have been found in Australia (Section 11.5) but not in the Americas, where our earliest knowledge is based on written records since about AD 1500.

Among the stingless bees, the larger *Melipona* species lived only in the Americas, whereas *Trigona* species were present throughout the tropics. Schwarz (1948), Nogueira-Neto (1970) and Michener (1974, 1979) described many individual species, and those known to have been kept in hives (Table 30.1A) are likely to have been exploited by honey hunting as well. Populations of stingless bees were reduced to some extent during the past few centuries, after honey bees were taken to the Americas and Oceania, and were more effective foragers.

The close similarity between honey collection from honey bee nests shown in prehistoric rock art and practices observed in the 1900s suggests that the hunting of nests of stingless bees in the Americas and Oceania in prehistoric times was similar to what is still done. In all its aspects, it seems to have been simpler and beset with fewer difficulties than hunting for nests of honey bees. Nests were generally nearer the ground, and in smaller trees – and could more easily be reached and opened up. The bees did not sting, and the work needed less equipment. It was not normally necessary to smoke the bees, and the chief tool was an axe (often of stone) for gaining access to nests. And in the tropics of the Americas and Oceania, there was no chance of an encounter with a honey badger, tiger or bear.

11.2 Mesoamerica

Mesoamerica is the area of the Maya and associated peoples, extending from about 10°N to 23°N (Figure 30.1a). It includes the Yucatan peninsula where stingless bees and their honey and wax were very important to the Maya people, the rest of Mexico, and Central America except the eastern parts of Honduras, Nicaragua and Costa Rica, and Panama.

Knowledge about honey hunting is largely lost, probably because bees were kept in hives from an early date, between about 300 BC and AD 300 (Section 30.21). The collection of honey from nests of stingless bees in Yucatan was, however, recorded by Bishop Diego de Landa in the late 1560s, after the Spanish conquest (Kent, 1984b). Around the same time Bernardino de Sahagun travelled through the part of Mexico that had been under Aztec rule since the 1100s, and he said that the people ate wild honey from stingless bees and other insects whenever they could obtain it; the honey 'was often consumed together with the bee-maggots'. Landa's *Relación de las cosas de Yucatán* (1566) repeatedly mentioned honey among tribute paid to the Spanish, probably by Acaxee people. In the region of Culiacán on the west coast of Mexico, the Acaxee did not keep bees but were skilled in collecting honey from nests, which contained 'wax pots as large as dove's eggs'. These people watched for bees collecting water, and followed them back to their nest (Bennett, 1964), as Columella described in Ancient Rome.

A 1653 reference to 'hives' by Bernabé Cobo might have meant natural nests. 'The combs are different from those in Europe, in that the bees put the honey into pots of thin wax that are like a hen's egg or smaller; in the season these are filled with very sweet, light honey that is in general use in New Spain [Mexico], because there is much of it in the province of Campeche.' Schwarz (1948) quoted a 1676 report

by William Dampier which mentioned bees nesting wild as well as those in log hives, in Tabasco on the Gulf of Campeche on the east coast of Mexico. Spaniards found that stingless bees did not thrive in the cool highlands of the Valley of Mexico, Puebla, Toluca, etc. (Brand, 1988). In the state of Michoacan west of Guerreros, honey hunters of the Tarascan village of Cherán collected nests during the day before a fiesta, and mounted them on two V-shaped structures known as *katárakua*, with the two largest at the top. They were held in place by large nets similar to the fish nets used on Lake Pátzcuaro.

Even in the 1900s, honey hunting seems to have been a more important occupation among the Chorti in Guatemala than keeping the bees in hives; a number of families were occupied with supplying wild honey to the market at Jocatan near the border with Honduras (Wisdom, 1940).

In the Nicoya peninsula of Costa Rica, beekeepers nowadays hunt in the forest for wild colonies to use in their apiaries, especially in the dry season when trees are bare, and it is easier to track flying bees to their nests.

11.3 The rest of Central America, and Caribbean and neighbouring islands

Outside Mesoamerica most of the honey and wax was obtained by hunting, since hive beekeeping was comparatively rare.

Pfefferkorn (1794/95) wrote as follows of the Sonora area at the northern extremity of the range of stingless bees.

> Only wild bees are known. Countless swarms of these industrious insects live in the mountains and the woods, nesting in hollow trees and crevices of rocks where they place their honey combs. The combs are in shape much like large and heavy clusters of grapes, and the wax cells containing honey are not hexagonal like those of the domestic bees in Germany, but are little oval bulbs which resemble grapes. Since each cell is as big as a hazel nut, it is clear that the combs of these wild bees are much larger and richer than the combs of our bees. The natives say that these bees have no stings ... Honey gathered by these wild bees is pure and tasty; the wax, however, is unclean, poor in quality, and very sticky. It is yellow and remains so, no matter how much it is washed and bleached.

Moving south of Mesoamerica to Panama and then South America, stingless bees are found in increasing number and variety. A few records are cited below under the present name of the country.

- Honduras: Considerable amounts of wild honey were collected in the forests; there was no beekeeping (Roys, 1972).
- Nicaragua: The Miskito got honey and wax from wild colonies; no beekeeping was recorded (Kent, 1984b).
- Costa Rica: The Talamanca hunted nests, and also Guaymi-speaking people who recently migrated from eastern Costa Rica to Panama (Kent, 1984a).
- Panama: Roubik (1986) estimated that honey was collected from 100,000 to 200,000 nests a year. Species exploited included *Melipona* (*fasosa*, *fuliginosa*, *fasciata*, *compressipes*) and *Trigona* (*pectoralis*, *capitata*, *frontalis*, *angustula*).
- Caribbean islands: A few species now live in certain islands in and around the Caribbean area: Trinidad and Tobago, where Laurence and Mohammed (1976) listed four; Dominica, Guadeloupe and Montserrat in the Leeward Islands; Cuba and Jamaica with a single species, which Schwarz (1948) named as *Melipona beecheii fulvipes*; see near the end of Section 3.6. In 1492 Columbus noted 'a variety of wild honey' as one of the natural assets of Cuba. On a later voyage he obtained wax in Hispaniola, now Haiti and the Dominican Republic. Records from the Lesser Antilles in the late 1600s refer to Caribs mixing honey with water to make a drink (Steward, 1963), which suggests that they also hunted stingless bees' nests for their honey.

11.4 South America

References cited below, from successive centuries, indicate honey hunting in regions that are now in eight countries of South America. Publications by Gross (1972) and Bierzychudek (1974/76) provide many further references.

11.41 References before the Spanish conquest

Long before the Spanish conquest in the 1500s, beeswax from stingless bees was collected and used for gold casting by the lost-wax method (Section 49.46), so the presence of the bees was important to pre-Columbian civilizations which had gold.

The following reports, from unknown sources, are quoted in case they can be confirmed.

- 1448-1482. During the reign of the Inca Tupac Yupanqui, he conquered some sylvan savages who were so poor that they could pay tribute only in macaws, monkeys, honey and beeswax (Georghiou, 1955).
- In 1572, when Spaniards reached the Inca town of Vilcabamba, at about 2200 m, just north of the Peru-Ecuador border, they were said to report that 'bees make combs in the boards of the houses as is their habit in Spain'.
- The Inca were familiar with propolis (Demidoff, 1986).

11.42 Reports by travellers during the colonial period

The 1500s

A number of reports were written by European travellers after the Spanish and Portuguese conquests in the early 1500s.

Bees were first mentioned by a German, Ulrico (Ulrich) Schmidel, who traversed the territory now in northern Argentina between Buenos Aires and Asunción. He arrived in Rio de la Plata in 1536 as a soldier in Don Pedro de Mendoza's expedition, and Figure 11.4a shows him on his travels. He returned to Europe in 1545, and wrote as follows in 1599.

> The land of these Macasis is very fertile and very rich in grasses, fruit and honey. An Indian goes into the woods with an axe, and the first tree he comes to has an entrance hole to a bees' nest. By boring other holes he gets 5 or 6 jugs full of pure honey. These bees are small and have no sting; their honey can be eaten with bread or other food, and a very good mead can be made from it, which is even better than mead made here in Germany. If there is nothing else to eat, both Christians and Indians have sufficient food with honey and wild roots found in the woods, without spending time hunting wild animals.

Figure 11.4a Ulrich Schmidel, author of the earliest European report on stingless bees in South America, travelling by llama in what is now north Argentina (Schmidel, 1599).

In 1555 Hans Staden, another German soldier, was held in captivity in Brazil by the Tupi. He noted that when the Tupi took honey from a nest, the bees often flew on them 'so that they were forced to brush them from their naked bodies'. When he himself went honey hunting, he dived into a stream to wash the bees off. Other European explorers and soldiers travelling through Brazil in the 1500s found more honey than they could eat, and Indians offered them gifts of it.

Father José de Acosta, a Spaniard who travelled to many parts of Bolivia and Peru in 1572, was given dark acid honey from bees that were very small, like gnats, and lived in nests in trees or underground – 'not in hives as in Castile, and the combs that I have seen in the province of Characas [Mexico]'. He thought poorly of the comb that contained the honey, and said that combs were 'much better formed' in Tucumán (Argentina), Cartagena (Colombia) and Chile (Acosta, 1590).

In 1578 Don Juan de Pimentel, Governor of the province that included the Spanish settlement at Caracas – now in Venezuela – reported that bees made many good nests in holes in trees, mentioning by name jobo (*Spondias mombin*, Anacardiaceae, which is a very good nectar source). The people in Margarita island off the north coast sold and bartered honey among other foods, and some also sold wax which in Venezuela was always black (Rivero Oramas, 1972).

The Jesuit Father Bernabé Cobo went to the Americas in 1596 and travelled in Mexico, Guatemala, Panama and Peru, as well as in Hispaniola (Haiti and the Dominican Republic). *Historia del Nuevo Mundo* (Cobo, 1653) contained several paragraphs on honey-storing bees.

> The smallest bee is the size of the fly that breeds in wine; another kind is somewhat larger, although smaller than the European bee. Both these have two castes, whose colour is different; neither can sting, but they burrow in the hair and beard. [Other descriptions follow.]

The 1600s

In about 1612 Simon wrote of the *Llanos* in Venezuela (grasslands between the Andes and the Orinoco River):

> There is much honey here, from 4 or 5 sorts of bees which make honey in different ways, some in tree hollows and without having combs as in Europe. Instead they make a wax pot about the size and thickness of an egg; they fill it with liquid honey, which has a good flavour. These 'eggs' are in a cluster, 20 or 30 or more together, and full of very fine and light honey. The wax is of a good enough quality ... All these [bees] are small in body, and tame [do not sting]. (Rivero Oramas, 1972)

Father Antonio Ruiz de Montoya included observations on bees in his *Conquista espiritual* (1639); he said that Asunción, especially, supplied inhabitants of Paraguay with commodities which included sugar, honey, wine and wax, and he knew of wax from 9 or 10 different kinds of wild bees; no one had yet domesticated them, but they bred very well in the mountains. In 1673 Father Nicolás de Techo reported rather similarly. Purchas (1657) described a number of Brazilian stingless bees and their nests and honey, from many sources and what the natives told him. *Zellobson* was larger than the English bee, and 'they have honey in abundance, and the further up the Country the more plenty; I have seen more [honey] taken out of a tree at a time than a Firkin would hold [about 40 litres] ... as clear as running water ... They have their honey in clusters of balls, much like our Humble-Bees'. Of another species, 'their wax is black as pitch, which they call *yetic*, they use it not for candles as wee do, but to stop [close] their great Canes, wherein they keep their feathers'.

The 1700s

In 1704 Johan Nieuhof said that 'the common Food' of the Tapuya in north-east Brazil was 'Fruits, Roots, Herbs, and Wild Beasts, and sometimes Wild Honey, which they take out of hollow trees'. Sánchez Labrador (1734-1798) wrote a series of studies on Paraguay, in which *El Paraguay natural* alone ran to nearly 2000 pages, and included descriptions of 11 native honey-storing species and much information on their wax (quoted by Bierzychudek, 1974).

Reyne (1962), who described 28 species of stingless bees in Surinam, quoted one report by Bancroft in 1769 that native peoples in Demarary (now Guyana) made large balls of beeswax 'which one could buy for a trifle', and another which stated that Surinam exported 2½ tonnes of wax in 1745, ten times as much as in 1717.

The 1800s

Writing about New Granada, now Colombia, Goudot (1846) mentioned the names *Melipona fasciata*, *Trigona fulviventris*, *T. mexicana* and *Tetragona elongata et quadrangula*. He also explained the seasonal cycle of honey storage, and said that honey hunting parties collected honey and wax in April/May and October. A tree was usually felled to get at a nest, which might yield 3 litres of honey and 1 kg of wax; the honey was sometimes sold in the market of Bogotá, packed into bamboo internodes. These often contained a mixture of honey from several species, and beeswax was similarly mixed. According to Bodenheimer (1951), around 1840 d'Orbigny recorded systematic hunting for stingless bees' nests in the forest by Chiquito in Bolivia. During June-September, organized groups of 10 to 20 men set out to search the forest for nests. Many of the trees were chopped down to get at a nest inside, and the part containing it would often be taken home and installed as a hive. Honey was plentiful in houses everywhere, but the first 75 lb (34 kg) of wax collected had to be paid as a state tax.

11.43 Some studies on hunting stingless bees' nests in the 1900s

In the late 1900s, detailed anthropological and ethnological studies were made on many honey-hunting peoples. Some peoples depended greatly on finding bees' nests and had an extraordinary knowledge of the different stingless bees in their area which must have been accumulated over many past generations. Others were also very effective honey hunters, and developed special techniques. Very many others are also known to have hunted for and collected honey among other foods, and I think it likely that this was probably done all over South America where stingless bees lived. The examples below indicate the richness and variety of the traditions in different regions of the continent.

Some peoples to whom bees were very important

To the Yukpa, a Carib people on the Venezuela-Colombia border, bees were an even more important food than honey (Ruddle, 1973). When hunting stingless bees, for instance *Trigona (Tetragona) clavipes*, they felled a tree to get at a nest, removed the honey pots and then passed the brood combs 'rapidly through a fire in order to kill the larvae without losing too much of the cerumen'. Soft cerumen from nests of stingless bees was shaped into balls for stor-

Figure 11.4b Schematic drawing of a *Melipona* nest in an upright tree cavity, with features for which Kayapó terms existed (Posey & Camargo, 1985).

On left:	*On right*:
A batumen	I pot opening
B honey pot	J entrance structure
C pollen pot	K entrance gallery
D brood cell	L cocoon
E brood comb	M shell of nest
F involucrum	
G pillar	
H lower batumen with drainage channels	

age and had many important uses, for instance in making stunning-arrows and hatchet-flutes.

The Kayapó, of whom only 2500 were left, lived near Rio Xingo in Brazil, at about 8°S 55°W. Field studies (Posey, 1982, 1983a, 1983b; Posey & Camargo, 1985) showed their intimate knowledge of different species of bees and their nests; see for example Figure 11.4b. Experts among Gê-speaking Kayapó in a reserve in parts of the states of Pará and Mato Grosso could identify two kinds of stinging bees (European and Africanized *Apis mellifera*), and 54 kinds of stingless bees (Posey, 1983a). Although a hunter generally took meat and other food to his wife or her mother in the village for distribution, he himself distributed honey as he pleased; it was usually consumed by members of the hunting group where it was collected, and rarely reached the village. Honey containers were made from layers of banana leaves, and men chewed a thick stalk base of wild ginger until it became an absorbent 'brush', then dipped it into the honey and pulled it through the mouth. When the container was empty it was taken apart, and the leaves licked so that no honey was wasted. Kayapó men liked 'to drink honey until they feel light-headed', and one boy was seen to consume half a litre at a sitting. The Kayapó used wax of stingless bees for many purposes, and Figure 49.3c shows the ceremonial hat made of it.

The Guayaki, nomadic hunter-gatherers in Paraguay (20°-23°S), used a 10-m rope made of plant fibres mixed with human and animal hair; they sometimes bent two young trees into an arch and supported a seat from them, level with the nest to be harvested (Steward, 1963). These people were studied by Nordenskiöld (1929a, 1929b) and were the subject of Vellard's 1939 book *Une civilisation du miel*. They did not cultivate the land or make dug-out canoes, and Nordenskiöld thought that their stone axe was used primarily for getting access to bees' nests; the axe was carried up the tree on a leather thong attached to the wrist. They transported and stored honey (most of it from *Melipona* species) in large basket-jars that had been made impermeable by a thick lining of beeswax. The honey was very liquid, and they extracted it from these jars with absorbent brushes made from crushed twigs of the pindo palm (*Cocos romanzoffiana*). Beeswax, which contained much resin, was kneaded or chewed, then melted over a low fire and made into smallish balls; when needed for use it was remelted. The wax protected bows and arrows against damp, and kept ropes in good condition. It was mixed with rich soil from swamps to make the only form of Guayaki pottery, which was not fired.

Vellard reckoned that honey formed the basic Guayaki food: whatever else might be lacking in their camp, there were always stocks of honey and wax. If a group of people moved camp because they felt endangered, they always took their honey and wax with them. Unusually for these honey-hunting peoples, the honey was shared among all members of the group.

The Mataco lived in Gran Chaco, a vast open dry plain stretching from 18° to 32°S across parts of Paraguay, Argentina and Bolivia, which include dry forest. Honey hunting was very important to them, and honey was one of their main foods. Alvarssen (1988) spent six years with the Mataco, and studied

their honey hunting in detail. They could distinguish 19 kinds of stingless bees and their individual honeys, and they knew when nests of any species would contain honey and/or brood. They located a bees' nest by watching or listening for flying bees, or by identifying a bee seen collecting water and following it to its nest. (According to Métraux (1963) the Abipón in Gran Chaco plucked their eyelashes to improve their vision for this purpose.)

The Mataco knocked or tore down a nest suspended in the open, but remade most bees' nests after harvesting from them (Section 17.22). When getting honey from one species (*chiguana* in Spanish), a hunter used smoke and protected his head by pulling over it the string bag that he commonly carried, but no protection was worn when working at other nests. Métraux said that the Guaná blew smoke from a *Datura* plant (which would probably be toxic) into the nest cavity before taking the honey. The Tupí-Cawahib, remnants of an ancient Tupí people in the south of the Amazon basin, killed bees before taking their honey by closing the nest entrance with a pad of leaves from an unidentified tree (Steward, 1963).

The Mataco squeezed the honey out of the honey pots into containers made from soft skins of rodents or from oblong calabashes. If no container was to hand, a temporary one was made from the soft wood of a bottle tree (*Cherisia insignis*). Any honey spilt in the nest was mopped up with a bunch of forest lichens which was then squeezed over the container. The honey harvest from a nest was 1 to 4 litres, and was used as a cash crop; most was sold in the market or from door to door in the nearest town. But if a nest contained only a little honey, this was eaten on the spot. Any suitable larvae were carried home, to be eaten roasted or used as fish bait.

Techniques used by some other peoples

The Botocudo, near the coast north-east of Rio de Janiero, felled a tree containing a nest and enlarged the hole to remove combs and brood, then soaked up any honey left at the bottom of the cavity with a brush of shredded fibres, and squeezed it out into water (Métraux, 1963).

The Caingang (non-Guaraní peoples inland from Rio and São Paulo) used two loops of rope to climb a tree. One loop was passed round the feet and the other round the tree and the climber's back; the two were moved alternately up the trunk (Métraux, 1963). One group used only a single rope, of bamboo strips; Figure 8.4b shows a similar method in Africa. Peoples of the Montaña on the east side of the Andes in Ecuador and Peru used 'climbing rings' (Steward, 1963), which were perhaps similar.

Other honey hunters

Steward (1963) and others referred to or implied honey hunting by further peoples, including the following which are listed roughly in order from north to south.

- Guaymi, a Talamanaca people in the Caribbean lowland
- peoples in the Venezuela *llanos*, especially the region between Río Barinas and Río Apure which was described as 'one great bee hive'
- all peoples of the Guianas
- Akoerio and Wayarekule in Surinam
- Tolú in south Colombia
- Tucuna south of the Amazon-Solimões River
- peoples of the lower and middle Xingo River in the Amazon forest
- Tarairiu, nomads on the most easterly coast of Brazil
- Camacán, inland from the coast near Salvador (Bahia)
- northern Gê (who stored honey in skin bags) and north-western Gê, in Brazil south of the Amazon
- Cavinia in the Peruvian highlands
- Aymara in the Titicaca Basin, in Peru and Bolivia
- Chiquito in Bolivia
- Araona in eastern Bolivia
- Purí, nomads near the coast north-east of Rio de Janeiro
- Ache and Ashluslay in Gran Chaco
- Cainguá and Toha in Paraguay and Argentina
- the Tupi-Guaraní in the extreme south of Brazil
- Atabambi in islands of the Paraná delta in the south of Brazil.

11.5 Australia and Pacific islands

11.51 Early traditions in Australia

The first people to reach Australia came from south-east Asia around 50 thousand years ago (Section 6.1). There were no honey bees as in Asia but, instead, small stingless bees. The people harvested honey and brood to eat, and also wax which was valued as an adhesive and a medium for making cult objects (Section 49.31). Descendants of these people, called Aborigines by European explorers and settlers, left no written accounts, but pictorial records of bees'

Figure 11.5a Rock painting of a nest of stingless bees, Perulba, Prince Regent River, Kimberley region, WA (Register AU-01, photo: I.M. Crawford).

nests survive: painted on rock and on bark from eucalyptus trees, and carved on ceremonial wooden pipes.

Rock paintings showing bees' nests are discussed in Section 6.2, and five (AU-01 to AU-05) are known in Australia. AU-02 and AU-03 (illustrated by Crawford, 1968, and Crane, 1975a) are at Secure Bay near Darwin, Northern Territory. Aborigines believed that the bees spread over the country from that area, and indeed Secure Bay is in the part of Australia which first became accessible by land from New Guinea. Perulba in the Kimberley region, WA, is one of the places the bees were believed to have arrived first, and Figure 11.5a shows a painting at the entrance to a cave there which also contains paintings of flying foxes, squirrels (gliders), possums and a sting ray. Albert Barunga told the legend of the bees' arrival to Crawford (1968), as follows:

> The bees separated, different ones went to different places. Some went towards the rock, and others went up the river ... Another one was not happy and kept going. He crossed over the Prince Regent and on the other side he found the place called Perulba and there he said: 'I'll try and lie down', and he lay down and was contented. ... That is the place he remained in, and he became painted on the cave from then until now. ... Flying foxes and squirrels were all around that area, feeding when all the flowers were open, ... and when they were full they all came back home. When they were on their way, they found the cave with the bee lying down, so they lay down with him. They joined him.

A rock painting (AU-04) found by Percy Trezise (1973) on headwaters of Coamey Creek 120 km north of Cairns, Qld, shows two horizontal nests; one is about 4 m long. Bees (not visible in Figure 6.2a,F) leave the entrance tunnel at the right end, some as dots and others with wings, and four much larger bees are perhaps queens. At the left end is a honey hunter about 30 cm high, using a stick to extract honey from cells in the nest, as is still done today. Another rock painting (AU-05 in Arnhem Land, NT) is attributed to mythical beings; one of them, Adungun, carries a honey bag over his shoulder. Similar bags appear in bark paintings (Figure 11.5b). Aborigines traditionally made both sacred and secular paintings on pieces of bark from certain eucalyptus trees. The earliest known are 10,000 years old, and Baldwin Spencer (1928) described how they were produced. Certain paintings, used for initiating the young in tribal tradition, were secret and were destroyed afterwards, but other, celebratory, paintings

Figure 11.5b Bark paintings showing individuals carrying a bag for collecting honey combs (Spencer, 1928). *left* Man and woman, only the man with a honey bag; *centre* Kangaroo hunter; *right* Emu hunter.

were left in place, and some later ones have survived. Tettamanti (1983) described those that relate to bees and honey. The example in Figure 11.5b includes several legendary men carrying a bag for honey over one shoulder, some of whom are hunting kangaroo and emu. Bodenheimer (1951) referred to bark paintings in which women as well as men carry these bags.

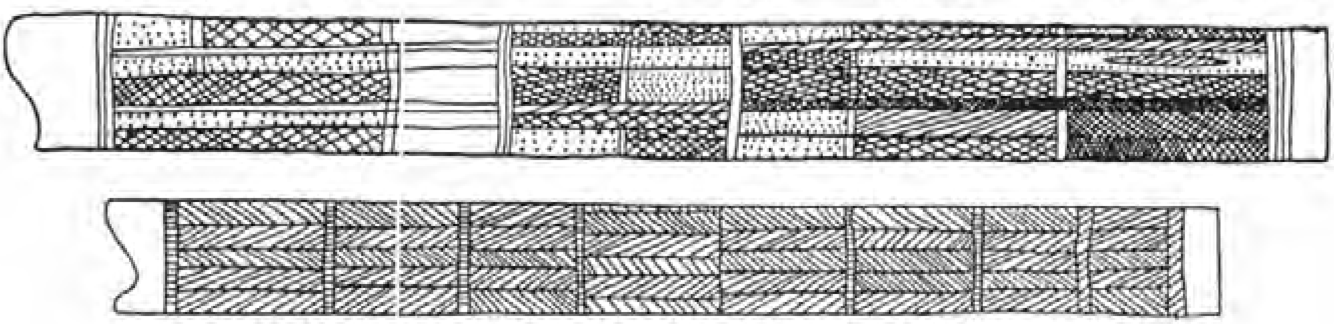
Figure 11.5c shows an example of the ceremonial pipes smoked by elders during rituals, carved with designs representing the legendary male and female ancestors of nests of stingless bees. These ancestors were believed to live in a hollow tree at a totemic site near the great Macuti marsh on the Koolatong River in Arnhem Land; the male ancestor was the wild honey totem. Tettamanti also published a body-painting that includes water lilies and nests of stingless bees in the Matamatui marsh.

11.52 Australian records from the 1600s onwards

The earliest written record found was by Abel Tasman in 1642. When he landed on the island later named after him, he noticed that many trees had notches in them, and the Aborigines used these to reach nests of stingless bees (Australian Bee Journal, 1970).

In the 1800s a few travellers, and writers from the several European settlements in Australia, mentioned the Aborigines' honey hunting. The greatest number of reports came from Northern Territory and then – in decreasing order – from Queensland, New South Wales, South Australia, Victoria, Western Australia and Tasmania. In 1859 Charles Darwin said that 'in Australia the imported hive-bee is rapidly exterminating the small, stingless native bee'.

Figure 11.5c Ceremonial pipes from Yirrkalla, carved to represent the ancestors of nests of stingless bees: male (above) and female (below) (Tettamanti, 1983). *cross hatching*: Honey pots; *dots*: Pupae. The small cigar-shape at the top right represents the male ancestor resting in a hollow tree.



Stingless bees are now extinct in Tasmania, and probably in Victoria too (Dollin, 1987). None live in the central desert, but honey ants were a source of honey there (Section 13.4).

Table 11.5A
Some stingless bees (Meliponinae) exploited by Australian Aborigines

Species	*Region or state*	Ref.
Austroplebeia australis	southern states	B51
A. essingtoni	Northern Territory	D88
Trigona carbonaria	southern states; Cape York, Qld	B51
T. hockingsi	Cape York, Qld	D83
T. laeviceps	Cape York, Qld	D83
T. mellipes	Arnhemland, NT	D88
T. wybenica	Cape York, Qld	D83

B51 Bodenheimer (1951); D83 Dollin & Dollin (1983); D88 Dollin & Dollin (1988)

It is not now possible to identify species referred to in many of the early records, but Table 11.5A lists species known to have been hunted for their honey and wax in the recent past. Almost all nests mentioned were in trees, some of which were 'tall', but the bees also nested in rock crevices, termite mounds and man-made buildings, and under the ground. Observers in Australia were especially impressed with the cleverness of Aborigines in locating nests and extracting honey from them. Procedures are treated below in the order: finding a nest, reaching it, pacifying bees, handling the nest, and harvesting. Information is largely based on first-hand accounts collected by Bodenheimer (1951) and on some by Tettamanti (1983).

Three methods for finding nests were recorded in 1928 at Powell Creek, NSW, and elsewhere. Firstly, Aborigines walking through the bush were constantly on the look-out for anything that might be useful to them; they had extraordinarily keen eyesight, and in the Herbert valley, Qld, Lumholtz (1890) reported that in clear weather Aborigines passing beneath a tree up to 30 m high could see bees (only a few mm long) congregating round a nest entrance. Secondly, a honey hunter would seek out a tree likely to contain a nest and put his ear against the trunk in many different places; if a nest was present, he could gauge its exact position by listening to the sound of the bees through the wood. Thirdly, it was recorded in Victoria and elsewhere that an Aborigine would follow a foraging bee to its nest, having first fixed a particle of down or fluff to its body; in one place, resin from a tree was used as adhesive. This marking of bees is likely to be a very old practice in Australia, as elsewhere, and it was said to be used by a legendary honey hunter of northern Australia. He climbed a tree with the aid of a forked stick, as is done today, to a place where bees were foraging, and marked them with silk teased out from a spider cocoon, 'singing out to them to go home' (Spencer, 1928). In Groote Island near Darwin, NT, an Aborigine said that he spotted fragments of pollen dropped by foragers, and followed the line of them to the nest (Dollin, 1987). The bees were only 3 mm long, and I wonder if the trail was perhaps not pollen itself but droppings pigmented by ingested pollen. Still another method was said to be used by certain experienced honey hunters on the north coast; they could 'smell' their way to a nest from a considerable distance (Basedow; see Bodenheimer, 1951). This may refer to a species of bee that produces a pheromone whose smell is recognizable by humans (a pheromone of *Lestrimelitta limão* in the Americas smells of lemon).

Climbing a tree to reach a nest did not seem to present any particular difficulty. Sometimes a forked stick was used, perhaps like that in Figure 9.3b(B). On Cape York Peninsula, Qld, toe holds were cut in the tree trunk, or a rope was made from vines. To reach an underground nest, the hunter dug carefully along the entrance tunnel until he found it. If a nest in a rock fissure or a tree was inaccessible, a thin stick might be pushed into the honey pots, and the honey caught as it drained out. A blunt tool was used similarly when harvesting honey from hives of stingless bees in Yaxcabá in Yucatan (Section 30.23). Alternatively, as in the Victoria River region, NT, a bundle of fibres of pounded bark was tied to the end of a long stick and forced into the nest. When the honey pots were reached it was turned round and round until it became soaked in the honey, then withdrawn, and the honey squeezed into a container; the process was repeated as many times as was necessary. In Mitchell River a rope made of grass or palm fronds was used instead, and the honey collected in a bark dish (Dollin, 1990).

In a 1908 report on some Aborigines near Alice Springs in central Australia, the collection of honey from a small stingless bee about the size of a housefly – said to present no difficulty – was the privilege of the men (Flood, 1995). But in many regions women and children hunted for nests of stingless bees, and in 1906 Thomas described how girls of one tribe played a game to learn how to get honey (Bodenheimer, 1951). They squatted on the ground, and placed their hands one above the other, with the fingers downwards to represent a tree. The hands were then knocked down from above to imitate the felling of the

tree, and the arm of one girl was made to represent the branch containing the nest. Symbolic chopping at her elbow with an axe cut the branch down, and the honey was secured and put in a trough of cupped hands, where it was mixed with water. (The arm was 'cut off' at the elbow, not the shoulder, because women were forbidden to obtain honey from the higher parts of trees.) Aboriginal women in northern Australia still collect honey; for example in the Victoria River district of Northern Territory, where sugar-bag (a stingless bee nest) is regarded as a special delicacy, they use heavy wooden digging sticks to prise it out of termites' mounds, rock crevices or holes in trees (Flood, 1995). As a result of frequent fires most trees are not large, so nests are within reach of the ground.

11.53 Treatment of harvests from nests in Australia

Most of the honey from a nest was often consumed on the spot, and a honey hunter might put a very small nest whole into his mouth. But honey yields from some nests were quite large: amounts of 2 kg from *Trigona carbonaria*, and occasionally 20 kg or more from *Austroplebeia australis*, have been mentioned. Any honey not eaten might be carried in bags or bark baskets made for the purpose; these were like other baskets but smaller, more solid and with close joints, and sealed with beeswax. All or most of the nest contents was likely to be used, and honey was not normally separated from the comb or brood before being eaten. However, in the Herbert valley, Qld, Aborigines did not eat brood (which was sour) even if they were hungry.

In northern Australia, if honey had become mixed with sand or grit, or absorbed by fibres of a honey bag, it was extracted with water and the mixture drunk. Or a special fine grass was chewed to make a tuft or sponge, and this was dipped into the honey solution and then sucked. After use the tufts might be carried in the honey basket for re-use. In Queensland the inner bark of a tree was beaten and chewed to make a spongy mat for dipping into honey. Members of a household would suck it in turn, and this was 'very sociable and economical'. 'Watering the sugar-bag' extended the amount of liquid, and helped to clean the wax for use later.

Some Aborigines made an alcoholic drink from honey, and others made one from nectar of *Grevillea excelsior* (Section 48.6). Two uses of beeswax are mentioned in Chapter 49.

Many European observers who tasted honey directly from honey pots in a nest commented on its fine flavour (Bodenheimer, 1951), but honey separated from the nests after collection, and thus possibly mixed with other materials, was often described as sour and unpleasant (e.g. Lumholtz, 1890). On Cape York much aromatic honey which did not granulate was obtained from *Trigona carbonaria* (see Tettamanti, 1983).

11.54 New Guinea and Pacific islands

There are comparatively few records for the island of New Guinea, which was still part of the Australasian land mass during the Pleistocene period. Nests of stingless bees in the subgenera *Trigona* (*Plebeia*) and *Trigona* (*Tetragona*) were traditionally exploited for their honey and wax in Papua New Guinea (Kidd, 1979). Probably the brood was eaten as well, since Bodenheimer (1951) quoted an 1875 report that Papuans ate 'all insects without exception, raw or cooked'. Stingless bees are absent from New Zealand and from almost all Pacific islands, but they occurred in the Solomon Islands near New Guinea, where the inhabitants collected and ate insects.

12

Honey and Bee Hunting in the Americas and Oceania: Introduced Honey Bees

12.1 The impact of introduced bees

Both honey bees and man evolved in the Old World. Peoples descended from those who first reached the Americas and Oceania encountered honey bees only after settlers from Europe successfully transported hives of European bees (*Apis mellifera*) there (Chapter 36).

Beekeeping flourished in many of the settlement areas, and swarms from the hives established colonies in hollow trees; these also prospered, and later generations of swarms spread further afield – often well beyond existing settlements. People travelling through country not yet settled might thus see honey bees, which had their nests in trees, and European incomers harvested honey from the nests. (They were, however, culturally distant from Old World honey hunters with their centuries-old traditions and skills.) Sometimes they took home only the honey; sometimes they took the section of a tree containing a nest and set it up as a log hive so that they could harvest honey from it in future years. Some settlers also hunted for bees' nests to get bees to put in existing hives.

In many areas honey bees spread faster than the new human immigrants (Section 12.21). Along the Missouri River, USA, the rate of advance of honey bees around 1800 was recorded as 600 miles in 14 years, an average of 70 km/year (Oertel, 1976c), but this is unlikely to have been unaided by man (Schorger, 1967/68). In Papua New Guinea in the 1970s, the rate of advance was 20 km/year along valleys (Kidd, 1979). These rates are much lower than the advances of 300-500 km a year by Africanized honey bees in South America (Section 36.63).

12.2 North America: from around 1620

Table 36.2A lists some early introductions of honey bees to the Americas; the first to Bermuda by 1617. In the 1620s bees were sent to the early settlement in Virginia on the well wooded east coast of the mainland (Section 36.22(a)). Other parts of North America were also covered with virgin forest which provided a good environment for the survival and spread of honey bees. Thomas Jefferson, who later became the third President of the United States, wrote in 1788:

> The honeybee is not a native of our country. Marcgrave, indeed, mentions a species of honeybee in Brazil. But this has no sting, and is therefore different from the one we have, which resembles perfectly that of Europe. The Indians concur with us in the tradition that it was brought from Europe, but when and by whom we know not. The bees have generally extended themselves into the country a little in advance of the settlers. The Indians, therefore, call them the white man's fly, and consider their approach as indicating the approach of the settlement of the whites.

The term 'white man's fly' was not new; in 1721 Dudley wrote: 'the *Aborigines* (the Indians) have .... for many Years called a Bee by the name of the *English Man's Fly*.'

Settlers obtained some prodigious honey yields from natural nests, and the practice of honey or bee hunting has continued up to the present, although latterly it has often been done as a sport rather than of necessity.

12.21 The spread of 'wild honey in the woods'

Table 36.2B lists the earliest known dates when the presence of the European honey bees is attested in individual states and provinces. Early reports which are quoted below, roughly in chronological order, give an idea of the wealth of wild honey available in an area both before and after beekeeping began.

By 1639 bees had spread through the Massachusetts woods, and in 1641 a court case was concerned with the ownership of a wild colony. Goodman Kirtland had given Jno. Deacon a tree in his woodland,

in settlement of an earlier claim. The next winter Deacon employed a man to fell the tree, who reported: 'I laid my head to ye tree and there [was] a humming, and I said there is bees.' Deacon claimed that the bees were his, but Kirtland testified: 'I gave him [Deacon] ye tree but not ye bees.' The jury decided that if the bees were living and well in the spring, only the costs of the court case (15 shillings) should be paid, but if all were dead, 30 shillings (Adams, 1921). At that time a good 'stok of bees' was worth about 15 days' labour by a skilled craftsman. By 1649 people in Virginia 'have store of bees in their woods, make plenty of honey and wax ...'. In Swedish settlements in Pennsylvania between 1630 and 1707, 'Bees thrive and multiply exceedingly ... the Sweeds often get great store of them in the woods where they are free for any Body ...'.

In south-eastern states, wild honey was collected in Marion county in North Carolina between 1705 and 1712 (Grey & Thompson, 1933); in 1730 honey bees were plentiful in the Carolinas, in both hollow trees and log hives, and they produced 'vast quantities of honey and wax'. In Florida, bee trees were very common in cypress swamps by 1765, and 'honey bees, honey and wax could be taken from them'. J.W. Bartram also commented on the great numbers of wild bees there in the 1770s, and the large quantities of honey and wax obtained by both native people and settlers. By 1758 bees were building nests in trunks of trees in Louisiana. In 1766 'wild honey produced a welcome luxury' in Tennessee, and in the early 1780s there were 'many swarms in the forests' of neighbouring Kentucky. By 1794 swarms were abundant in different parts of Alabama after settlement began; there was also much honey in Georgia and probably also Mississippi. Colonies were not seen west of the Missouri River until 1809; beyond were almost treeless prairies which had bleak and cold winters, and lacked nest sites. The bees were in Arkansas by 1818, and Irving's 1832 description of a bee hunt was set in Oklahoma.

The earliest reference found for Texas is by S.F. Austin who got $1\frac{1}{2}$ gallons of honey from a bee tree west of Trinity River in 1821 (published 1903). An 1834 report stated that 'the bee hunter was constantly employed to secure the honey and wax for exportation and trade'. Texas was in Spanish hands from 1819 to 1836, but Oertel (1976d) rejected reports that Spanish missions had introduced honey bees from Mexico during this period. Oertel (1976a-g) published many of the early records of honey bees in eastern USA.

Farther north, swarms were in Ohio in 1704. Bees were 'abundant' in Detroit, Michigan, by 1776, and Fenimore Cooper's 3-volume *The bee hunter; or, the oak openings* (1848) gave a detailed account of honey hunting in 1812. In Iowa both native peoples and European settlers were cutting honey from hollow trees in 1797. Trappers reported first seeing honey bees in Illinois about 1800, and in 1818 'more honey was available [there] than elsewhere in the world'.

By 1820 the bees were probably in Wisconsin, and settlers found many ladders and bee trees used by native Americans; by 1842 'thousands of swarms were destroyed annually by Indians and whites'. Schorger (1967/68) gave this and much more information about the great abundance of honey, and its collection from nests in trees. Wisconsin subsequently produced more wild honey than any other state outside New England. There and elsewhere, the bees advanced most rapidly at the margins between forest and open land (prairie grassland or smaller clearings). Flowering in the woods mainly finished before mid-June, whereas in grassland it continued into late summer. Schorger, who published a map showing known locations of early bee trees (most in the south of the state), suggested that their frequency was also due to the presence of 'oak openings' in the forest. Wisconsin was unlike many other states in that a number of native people were said to be occupied in honey hunting; as one might expect, they were expert at locating bees' nests. They maintained large areas of the land as prairies by burning off grass, underbrush and some trees, and many of the trees that survived were hollow and provided nest sites for bees (Gojmerac, 1990). Wisconsin still has a number of place names related to bees: four Honey Creeks, three Honey Lakes, a Honey Island, Bee Bluff, Bee Hollow and several Beetowns.

Section 36.22(c) refers to the later introduction and spread of honey bees in Canada from the 1770s onwards. Winters there were long and cold, and the honey storage period short; in most areas that were settled early, swarms which nested in trees may well not have survived the next winter. Extensive enquiries in Canada failed to locate information about honey hunting there.

12.22 Methods of honey hunting and bee hunting

In this book 'bee hunting' implies that the bees were wanted, but in North America the term was also applied to hunting bees' nests for their honey. Whichever the aim, procedures for locating and getting access to a bees' nest were the same.

Men who took up honey and bee hunting worked out for themselves many of the techniques that had

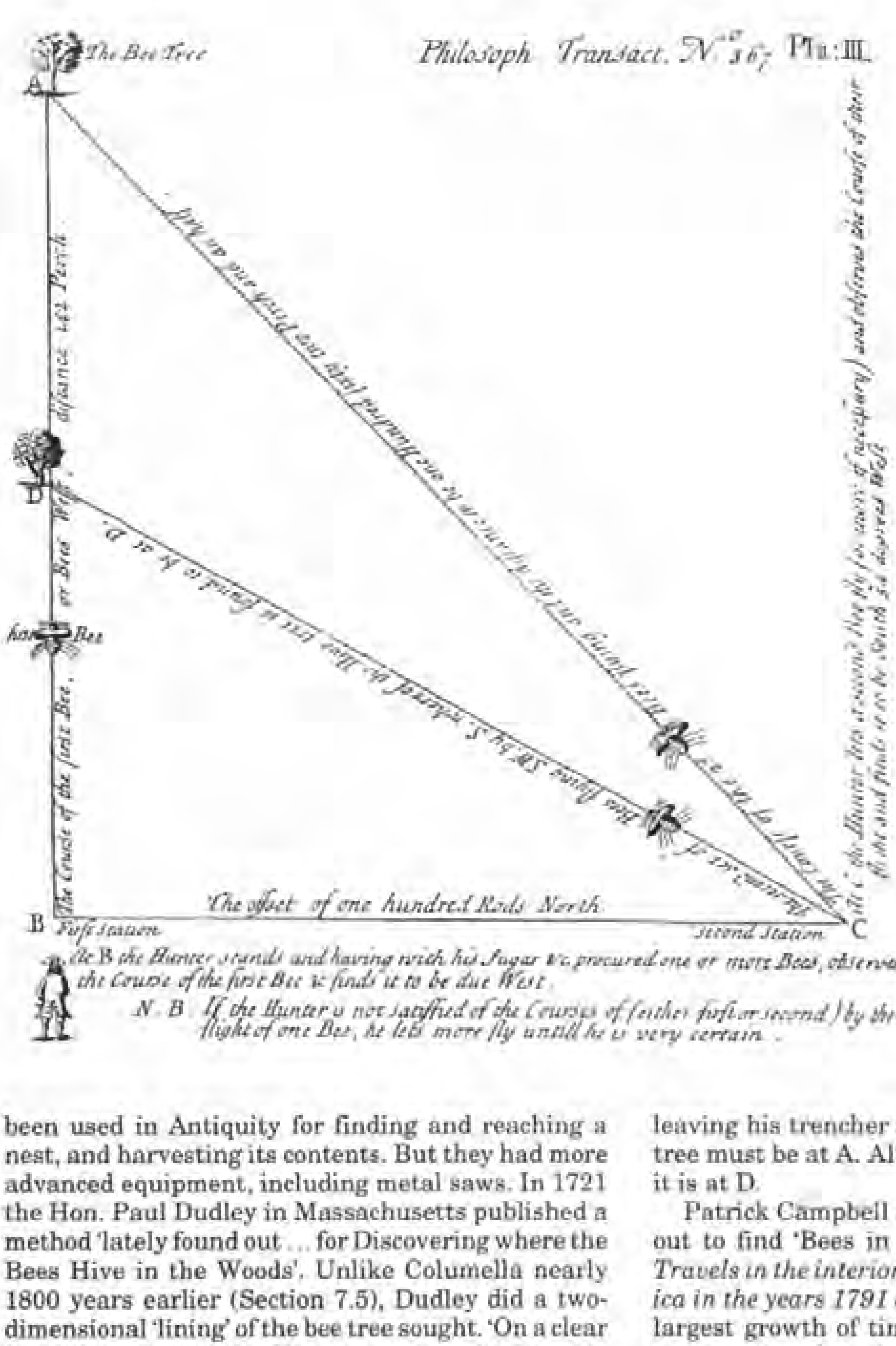


Figure 12.2a Diagram showing how to 'line' a bee tree (Dudley, 1721). See text for details

been used in Antiquity for finding and reaching a nest, and harvesting its contents. But they had more advanced equipment, including metal saws. In 1721 the Hon. Paul Dudley in Massachusetts published a method 'lately found out ... for Discovering where the Bees Hive in the Woods'. Unlike Columella nearly 1800 years earlier (Section 7.5), Dudley did a two-dimensional 'lining' of the bee tree sought. 'On a clear Sun-Shiny day ... the Hunter carries with him his Pocket Compass, his Rule, and other Implements, with a Sheet of Paper.' In Figure 12.2a, the hunter puts honey on a plate or trencher at his first station B, and it is supposed that bees taking it fly due west (upwards in the diagram). The hunter then moves to the second station C, which is 495 m north; bees leaving his trencher there fly 54° W of S, so the bee tree must be at A. Alternatively, if they fly SW by S, it is at D.

Patrick Campbell described how a man would set out to find 'Bees in the Woods' in autumn, in his *Travels in the interior inhabited parts of North America in the years 1791 and 1792*. When he came to the largest growth of timber he lit a fire, placed a flat stone in it and on the hot stone some beeswax; on a nearby stone he put a little honey and sprinkled vermilion round it. A bee, attracted by the smell of beeswax, found the honey and became marked with red. He noted her direction of flight with a compass and awaited her return, timing the interval with his watch. From these data he could fairly easily locate

the nest. The tree was usually felled with a saw, because chopping by an axe disturbed the bees.

As time went on, both Dudley's baited trencher and Campbell's colour-marked honey, from which bees flew to their nest, were replaced by a purpose-made bee hunter's box. (As a boy, John Muir improvised a bee box in Wisconsin in the late 1850s, published 1913.) Referring to Mazomanie in Wisconsin in 1847, Schorger (1967/68) quoted the following:

> Parties go bee hunting for months together in Summer, they take wagons and a pair of oxen, an ax and coffeepot, and that's all except barrels for the honey. When they come to a prairie they turn out the cattle, and if they locate a bee tree, they chop it down, smother the bees and take the honey, barrel it up, then *ditto*, several times a day perhaps. They shoot for meat, roast corn in a frying pan for coffee, barter honey for

Figure 12.2b Bee hunter's climber (Root, 1877).

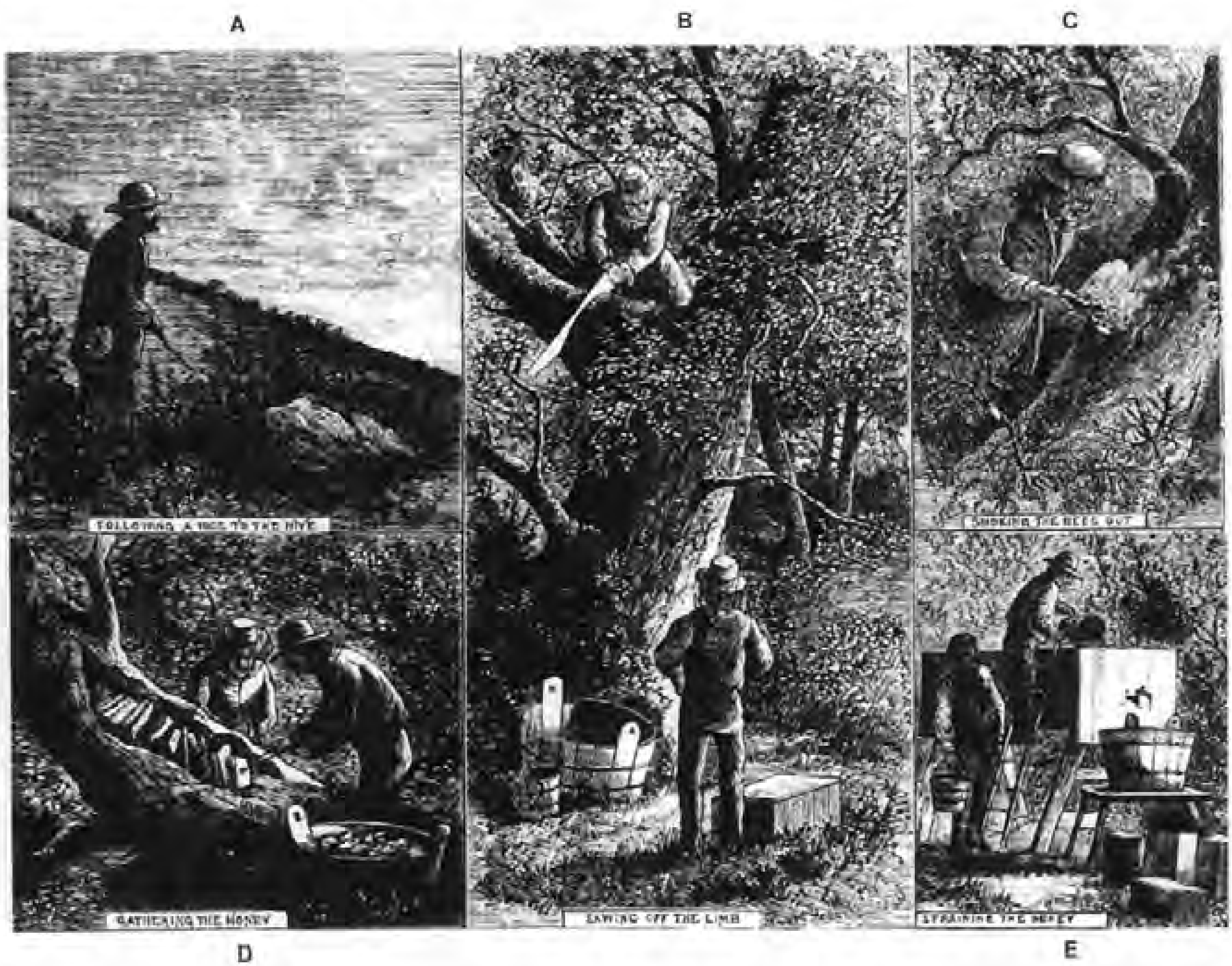


Figure 12.2c A bee hunt in North America (probably California), from *The Graphic*, 16 April 1881. See text for details.

flour from settlers, bake it in a pan, and sleep in their wagons at night.

A.I. Root (1877) in Ohio showed another type of box, and he gave detailed practical instructions for bee hunting – which he recommended – although he said that 'a beekeeper would stock an apiary much quicker by rearing the bees, than he would by bringing them home from the woods, and transferring [them to hives]'. He added: 'Many bee hunters brimstone the bees [with burning sulphur]; but I am so averse to any such method of killing bees that I have not the patience to describe it.' He also warned against expecting to get large amounts of honey in bee trees. Root's instructions show that North American bee hunters still lined up a bee tree by methods used in earlier centuries. For reaching a nest in a large tree, he recommended a pair of climbers (Figure 12.2b). A 'tough withe or whip', bent to go round the trunk, might be used in addition; it served a similar purpose to the climbing belt in Figure 8.4b. The bee hunter's tools (sharp axe, hatchet, saw and auger) were attached to a light line for convenience. Root instructed: 'If the bees are to be saved, the limb or tree should be cut off above the hollow, and allowed to fall ... If you only want the honey, and do not care for the bees, you can slab off one side of the hollow, cut out the combs, and let them down in pails.' He said that even if one side of the hollow was opened – as in Figure 12.2c(D) – the bees could very often be saved.

Figure 12.2c shows honey hunting, probably in California, in 1881. First, a laden bee was followed (A), and its nest in a tree located. The honey hunters then donned veils, and one sawed off the part of the tree containing the nest (B). When this was on the ground, the bees were smoked out with a piece of smouldering wood (C), the nest cut open and the combs put into wooden tubs (D). Honey was strained from the combs into a rectangular tank and drawn off into containers (E) for taking home. A further drawing showed the bees from the nest being 'transplanted' into a movable-frame hive.

Between 1915 and 1953, Allen Latham used the box in Figure 12.2d to find 250 bee trees in Massachusetts. Bees alighting on the honey comb in the left-hand compartment were trapped by closing the lid over them. The box was then taken to the point of release; by opening the internal central partition, a bee or bees could enter the right-hand compartment whose lid (shown separately) was still closed. A bee could then be released by opening the lid. Bee traps in North America may be compared with those in

Figure 12.2d Bee hunter's box, used by Allen Latham, Massachusetts, 1915 to 1953 (IBRA Collection B53/135).

Europe described under *Bee baits and traps* in Section 9.31.

Honey hunting continued in North America well into the 1900s, and in 1953 I visited two passionate bee hunters. G.H. Edgell, Director of the Museum of Fine Arts in Boston, had hunted nests in New Hampshire since his boyhood; he said that his book *The honey hunter* (1949) had brought him much greater fame than his professional publications on fine arts. Near Prospect, CT, Albert Allen demonstrated lining up bees with his bee box, which he had used to locate 150 bee trees.

Many others in the USA wrote on the subject; there were books by Donovan (1950) and Slater (1969), and articles by Cioch (1974) and Madson (1977). Gannon (1988) and Visscher and Seeley (1989) described more advanced technological methods of 'lining' a tree, and Levin (1989) dealt with finding nests in rocks in Arizona.

12.3 Caribbean and neighbouring islands from 1617, and Central America

European honey bees were introduced to Bermuda by 1617, and probably to Guadaloupe by 1689. In general, they were introduced later where stingless bees were present and their nests hunted (Sections 11.2, 11.3). In many countries honey bees did not arrive much before 1850, after which it soon became possible to keep them in movable-frame hives, and hunting was likely to be for the bees rather than for honey and wax. Table 36.2C gives dates of their

introduction to many Caribbean and neighbouring islands.

Honey hunting was reported in 1716/20 in St Kitts, and as late as 1988 in Bequia, St Vincent, and Nevis near St Kitts. Wild colonies were noted in Cuba in 1764 and in Santo Domingo (Hispaniola) in 1781. In Jamaica (Gilpin, 1886), 'swarms go off into the woods, and sometimes build nests in the open much like the *Apis dorsata* is said to do'. Men who harvested the honey were known as honey cutters in some Caribbean islands. In 1988 Duggan found that Bequia – a tiny island where there were estimated to be between 6 and 8 nests per km^2 – had several honey cutters, who also went to nearby St Vincent to cut honey from nests in rock clefts there. These were not beekeepers, but a honey cutter I knew on Nevis was a skilled modern beekeeper who enjoyed spending a day locating and collecting honey from a nest up Nevis mountain. He took about 40 kg of honey, disturbing the brood nest as little as possible so that he could cut honey again next year.

No records of honey hunting were found in mainland Central America, where honey bees were introduced relatively late (Section 36.23, Table 36.2A).

Bee hunting

Bees for use in hives were collected in recent years, and probably earlier, from natural nests in the uncultivated interior of many Caribbean islands, for example Antigua, Cayman Islands, Dominica, Grenada, Nevis, St Kitts, St Lucia.

12.4 South America: from 1839

The first honey bees in South America arrived in Rio de Janeiro, Brazil, in 1839 (Section 36.25), but in most countries they were not present much before movable-frame hives were used. Perhaps for this reason there is little evidence of honey hunting by European settlers.

Native peoples were familiar with stingless bees (Section 11.4), but we know rather little of their reactions to the larger, stinging *Apis mellifera* bees. Africanized honey bees, which spread through South America from Brazil from 1956 (Section 36.63), nested much more freely than European honey bees; their nests were smaller, and the bees were renowned for vigorous stinging attacks. Not much is known about the hunting of these nests. Hill *et al.* (1984) made a quantitative study on a group of Ache, hunter-gatherers in eastern Paraguay. Bees' nests in the forests provided an appreciable proportion of their food, and in the 1980s this contained much more honey from (Africanized) honey bees than from native stingless bees. The total calorie intake on different hunting trips averaged 3827 Kcal per man per day, of which 47% to 77% was provided by meat, 0.4% to 44% by honey and 6% to 45% by vegetable material and insect larvae. The calorie intake from honey bee nests (honey + larvae) was more regular and – if both sources were available – very much higher than that from nests of stingless bees.

In Figure 12.4a a Toha man in Argentina has just taken one of the combs from a nest in a tree felled for the purpose, after smoking the bees (Woodward, 1993). Figure 12.4b shows a typical scene of instant

Figure 12.4a A Toha man holding up a honey comb from an *A. mellifera* nest, north-east Argentina, 1989 (photo: Pablo Grau).

Figure 12.4b Group of Toha eating combs taken from the nest in Figure 12.4a (photo: Pablo Grau).

enjoyment when such combs containing honey and/or brood were eaten warm from the nest. Gilmore (1963), writing on ethnozoology in South America, said that *A. mellifera* was 'feral in many places, where its nests in trees are exploited as are those of native species. Its light honey sharply contrasts with the dark "strong" product of the stingless species.' Métraux (1963) reported that the Apapocuva (a Guaraní people in Paraguay and southern Brazil) collected honey, and that they 'spare several combs so that the bees can return. ... They also acclimatize swarms of bees to their villages.' It seems likely that this also refers to *A. mellifera*.

Bee hunting

No records have been found, but European bees were probably hunted after they had established themselves in an area, from 1839.

12.5 Australia: from 1822

European honey bees have been in Australia since 1822, around 50 years before movable-frame hives were first used (Section 41.51). There are fewer records than in North America of wild colonies or honey hunting; in drier regions, the survival of wild colonies may have been limited by lack of water, and also the high incidence of bush fires which could kill colonies and also prevent the flowering of plants during subsequent months, although eucalypts have a certain fire resistance (Lumbers, 1979).

In New South Wales, honey was obtained from natural nests during the 1860s (Mocatta, 1962/63):

> Anyone could have bees who had the courage to rob them. ... Aboriginals soon learned from their white brothers how to subdue bees by means of smoke, and with tomahawk and fire-stick, aided by strong vines, would ascend the loftiest and smoothest of trees to obtain the 'white-fellow's sugar bag'.

Bodenheimer (1951) quoted R. Semon's report in 1903, that wild colonies had recently spread from Dr Cole's apiary in Gayndah along the middle Burnett river, which was favourable for them. When a nest was discovered, 'often at a height of 10 m or more above ground, all the natives joined efforts to cut the giant tree, the work often taking the whole day'. By the early 1870s wild colonies were so plentiful in the bush that dishes and buckets full of 'bush honey' were on sale in the old George Street Market in Sydney; better samples were sold in bottles as 'pure garden honey' (Mocatta, 1962/63).

In 1906 it was said of both NSW and Tasmania: 'Nowadays bee [i.e. honey] hunting is generally confined to the settler in the backwoods, who wants a little honey. ... Some years ago, in the uninhabited country, bees were very numerous and bee trees easily located; bee hunting was not followed as a profession.'

Honey bees were in South Australia before 1846. In that year they were taken from Adelaide to Western Australia where, in 1881, a bee tree in Victoria Plains District yielded 3 gallons of honey [about 20 kg].

In Queensland the first bees arrived in 1851, and by 1869 'you could find a swarm in almost every hollow tree' (Roff, 1983). Roth (1901) published notes on the places in North Queensland where honey bees were not seen, but Puxley (1923) found them in many trees, and the bees had 'prospered exceedingly, like so many introduced species'. He accompanied a settler who spent a day cutting down a number of trees previously marked, taking the honey and putting the bees into hives; 'in this way he is building up a large business, for he sells honey ... which has cost him almost nothing'.

Bee hunting

Bees were obtained from natural nests in the 1860s (Mocatta, 1962/63), probably to put in log hives. In fact, much of the early beekeeping in Australia was based on colonies obtained from trees that were felled during land clearance, or in order to take the bees. In many forest areas the population of wild colonies became self-perpetuating. During the 1980s there was a proposal to remove such colonies from large forest areas of National Parks, but beekeepers considered that it would be impossible to implement (Keith, 1989).

12.6 New Zealand: from 1839

The first hives of European honey bees arrived in North Island in 1839 (Section 36.32), and by 1848 swarms had nested in many hollow trees near the Bay of Islands (Cotton, 1848). New Zealand had no stingless bees, and the aboriginal Maori had no tradition of honey hunting. Best (1977) commented that 'the introduction of the honey bee was a boon to the Maori, who is exceedingly fond of honey'. But what the Maori normally called 'honey' was nectar collected directly from flowers that secreted it in large

quantities. Like other Polynesians, they traditionally ate insects, and 'older Maoris still preferred to eat a mixture of honey, wax and bee grubs, just as it came' (Cotton, 1848). European settlers took honey from colonies in the bush, and yields were reported by G.H. in 1882 as 'frequently 100 to 200 pounds [45, 90 kg] and often more'.

Bees were probably collected from natural nests to put in hives.

12.7 New Guinea and Pacific islands: from 1857

The island of New Guinea is now divided into Irian Jaya (Indonesia) in the west and Papua New Guinea in the east. Honey bees were taken to the eastern Highlands of PNG in 1948, and within a year swarming was common; 'swarms escaped and feral colonies spread in many directions' (Kidd, 1979). By 1960 bees were widely spread throughout the Highlands; they nested variously in trees, hollows of large tree trunks, holes in the ground and roofs and walls of buildings. There were many wild colonies in the rain forest near Bubia (Michener, 1963). A colony could give up to 18 kg of honey.

Dates of the first introduction of European honey bees to individual islands in the Pacific are listed in Table 36.3A. The earliest was in Hawaii in 1857, a few years after movable-frame hives came into use in North America. On many islands swarms from hives might establish wild colonies, and honey was sometimes collected from them as the following examples show, but this does not seem to have created much comment or interest. The bees were 'common' in Suva, Fiji, in 1955/63 (Black, 1963), and 'present' in several of the major islands of Vanuatu (Burgett, 1987).

In New Caledonia much honey was collected from natural nests around 1900. On Easter Island the bees were introduced in the 1920s, and nests were hunted for their honey bees during the 1930s and 1940s, when there were no longer any bees in hives (Velasco, 1989). There are records of honey hunting in Tonga in 1968, North Mariana Islands in 1981 and Solomon Islands in 1983. Wild colonies were 'quite common' in the Kermadec Islands (Matheson, 1990).

Sirera (1953) described a method of finding a nest, which was used by 'magnificently tattoed' native people in an unspecified island where there are irrigation canals or reservoirs. One of the hunters, his mouth filled with water, sat and watched for a bee coming to drink; a change in the pitch of the sound from the flying bee warned him when she would alight. He forcibly discharged his mouthful of water on to the bee as she drank, and while she was recovering he fixed a little ball of cotton to her abdomen. He then followed the slow-flying bee to the nest. After making a dense cloud of smoke by burning coconut fibre, one of the hunters climbed the tree and used a long bamboo pole to dislodge the combs one by one; they were carried home in large palm leaves.

13

Honey Hunting: Bumble Bees, Honey-Storing Wasps and Honey Ants

13.1 The honey-storing insects

Section 4.3 explains how honey bees make honey, and the parts played by the enzymes invertase and glucose oxidase in the process. Other insects that produce honey – stingless bees, bumble bees, honey wasps and honey ants – also secrete these enzymes (Crane, 1991), although enzyme activities vary between different insect species. All the insects live in colonies, and all collect sweet liquids – their source of energy – from which they produce honey.

In different parts of the world, certain peoples also obtained sweet fluids or their products directly from the plants: nectar, honeydew and manna (crystallized honeydew), scales of the lerp insect *Spondyliapsis eucalypti* – and plant sap, mainly from sugar cane (*Saccharum officinalum*) and also certain palms.

13.2 Bumble bees

Most bumble bees live in north temperate regions. Each queen overwinters alone, usually below ground, and emerges in the spring to found a nest (Section 3.7), in which a little honey is stored during the summer. In Europe, nests of bumble bees were hunted when they contained most honey, and the practice was probably quite widespread among subsistence farmers.

The first few examples are from the Carpathian Mountains, now in Romania and adjacent lands. In the Fagaras region nests were found during grass cutting, and the scythe was used to cut out honey cells. In two places in the Hungarian Carpathians the adult bees were killed by scorching their wings before the nest was collected (Gunda, 1968). In Rétköz, peasants put dry weeds and twigs in the flight hole, lit them and stirred them up so that the bees flew. In marshy ground in the Erdőhat region, a fire was made over the nest with a similar result. In Hungary, nests were dug out with a stick (Figure 17.3a,A) or, as at Kék, a dog was trained to do it.

Estonians and Finns in the forests hunted the nests (Gunda, 1968), and Irish children did so especially at hay-making time (Charles-Edwards & Kelly, 1983).

Individual foraging bees were also caught for the contents of their honey sac. In 1595, William Shakespeare wrote in *A midsummer night's dream* (Bottom speaking to Cobweb): 'kill me a red hipt humble-bee on the top of a thistle; and, good monsieur, bring me the honey-bag'; this probably refers to *Bombus lapidarius*. Also in England, Gilbert White's *Natural history and antiquities of Selborne* (1789) referred to an idiot-boy who specialized in catching bees. 'In the summer he was all alert, and in quest of his game in the fields, and on sunny banks. Honey-bees, humble-bees, and wasps, were his prey wherever he found them: he had no apprehensions from their stings, but would seize them, ... disarm them of their weapons, and suck their bodies for the sake of their honey-bags.'

Referring to Wisconsin in the USA during the late 1850s, Muir recalled that native Americans 'had long been acquainted with the several species of bumble bees that yielded more or less honey' (published 1913).

In the tropics there are fewer bumble bees, but they were hunted by some peoples, even in areas where other bees or wasps stored more honey. In Mesoamerica soon after the Spanish conquest, about 1560, Bernardino de Sahagun may have referred to bumble bees when writing of 'drone bees in this country that make honey and construct nests in the earth where they make it. ... They sting like bees, pityful, and the sting swells.' The Aztec in Mexico valued honey from these bees as highly as that from stingless bees (Bodenheimer, 1951).

The Yukpa on the Venezuela-Colombia border ate many insects including bumble bees, and a child might have a large bee on a tethering thread as a plaything (Ruddle, 1973). In the Isle of Man off the west coast of England a bumble bee was caught and enclosed in a straw bumble cage, which was then tied to a crib so that the bee's buzzing would send the child to sleep.

13.3 Wasps

Honey from wasps

Colonies of social wasps cannot survive cold winters, but species in tropical and near-tropical regions may form perennial colonies, and some in South and Central America make and store honey. Section 3.8 gives brief details of their characteristics, and Table 13.3A lists species known to have been exploited by man for their honey; brood was also harvested from some.

The best known honey-producing wasps are species of *Brachygastra* (earlier *Nectarina*), and Figure 3.8a shows a nest of *B. lecheguana*. Buysson (1905) gave some details about the honey, which had a pleasant aroma and flavour, and how it was harvested. The suspended nest was smoked, then detached from its branch but leaving its base *in situ* so that the wasps would return and rebuild the nest. Schwarz (1929) measured nests of *B. mellifica* near Brownsville in Texas – probably near its northern limit – which were from 18 to 20 cm x 41 to 52 cm. Both he and Buysson were told that in times of drought the wasp's only forage plants were *Datura* species (common in Mexico) whose nectar is toxic, so the honey was then toxic to man. In Yucatan *B. mellifica* was hunted for its honey, which was 'dense and very tasty' (González, 1992). In the state of Nuevo Leon in Mexico, Eischen (1989) watched Mexican labourers harvesting from a nest of wasps, probably *B. mellifica*. They clipped the nest from the branches of an orange tree and carefully opened it and removed the combs of honey; some were eaten straight away by chewing the combs, and the rest taken home.

At the time of the Spanish conquest it was reported that the Aztec valued wasp honey as greatly as that from bumble bees and stingless bees; it was 'very yellow and very good to eat', Bodenheimer (1951) recorded this without naming species. In Mexico *Polybia occidentalis* was a source of honey which was 'sometimes poisonous or intoxicating, but is readily collected and consumed'. In Venezuela and Colombia nests of *P. ignobilis* 'invariably contained an abundance of honey during the latter part of the rainy season' (Ruddle, 1973).

Where the Kayapó searched for nests in Brazil (Posey, 1990), *B. mellifica* and *P. occidentalis* were regarded as the main honey-storing wasps. The honey was quite rare and highly valued, and considered to be very strong, and very good medicine. In Paraguay the Ache collected wasp honeys, but according to Vellard (1939) the Guayaki left them

Table 13.3A

Some honey-storing wasps in tropical and near-tropical America, known to be exploited by man

All the wasps are in the subfamily Polistinae of the family Vespidae.
In the final column:
small = maximum up to 100 individuals; medium = 100-1000;
large = 1000-10,000; v. large = over 10,000.
entries in brackets refer to the genus as a whole.
Many of the wasps were also eaten as larvae, pupae or adults.

Tribe	*Species*	*Region*	*Population*
Polistini	*Polistes annularis*	Texas, USA	small
Polybiini	*Brachygastra mellifica*	tropical America to S USA	v. large
	B. azteca	Mexico	
	B. lecheguana	Panama to Argentina	large
	B. scutellaris	S America	medium
	Nectarina = *Brachygastra*		
	Parachartergus apicalis	tropical America	medium
	Polybia atra	S America	large
	P. diguetana	S America	large
	P. flavifrons barbatula	N Peru to Mexico	large?
	P. ignobilis	Colombia/Venezuela	small/large
	P. occidentalis	S America, Mexico	medium
	P. paulista	S America	large
	P. scutellaris	tropical America	medium/large
	Protonectarina silveirae	south-east S America	medium
	Pseudopolybia compressa	tropical America	(medium)
	Stelopolybia pallipes	S America	(v. large)
	S. testacea	S America	large

untouched because some were regarded as toxic and others as intoxicating, having a 'stupefying property'.

Wasps as food

Many insect-eating peoples valued adult and immature wasps and their combs as food, whether or not the wasps produced honey. Ramos (1982) published photographs of a number of species whose brood, pupae, adults or comb were eaten. Many of them were sold in the markets, especially in the Mexican provinces Michoacán, Nochixtlán, Oaxaca and Zacatecas. They included *Myschocytarus* sp. and *Polybia parvulina* (Polybiini), *Polistes instabilis* (Polistini) and *Vespula squamosa* (Vespinae).

In north-west Guatemala, the Chuh Maya collected nests of *Polistes* wasps in which well developed pupae had striking black eyes; they liked their children to eat these pupae, believing that they would then also have large eyes (Evans & Eberhard, 1970). Brood of an unspecified wasp that does not store honey was eaten in the Andes, and 'all over Guiana' by peoples who included the Ronouyen (Bodenheimer, 1951).

The Yukpa used many wasps as food, including *Polybia ignobilis*, *Polistes canadensis*, *P. pacificus* and *P. versicolor*. Ruddle (1973) also cited species of *Auplopus* (Pompilidae) and *Pison* (Sphecidae), small solitary wasps which are not usually common. Pendant nests of *Polistes* wasps were hunted during all or most of the year. Both men and women located nests by day, and collected them after dusk – less accessible ones only by men. One man climbed the tree and used a hooked stick to knock down the nest attached to it. His companions seized the nest and flung it on to a fire already prepared; this drove off the adult wasps, 'and the larvae are killed and lightly toasted within just a few seconds'. They were eaten immediately unless very many nests were collected.

Australian Aborigines ate the white larvae from 'papery' nests of certain wasps that do not store honey. They held a bundle of flaming grass or bark beneath the nest, for just long enough to kill or disperse the adults, and then picked out the larvae and ate them raw (Cribb & Cribb, 1976).

Ordeal by stinging

This was quite widespread among native peoples in the Amazon basin, for example the Kayapó. The Royal Tropical Institute in Amsterdam has two breastplates devised for use in initiation ceremonies of boys of the Oyana peoples in Surinam. They were woven from stems of rattan or a similar plant, and many live wasps were affixed to the surface to be worn next to the body. The initiate had to wear the breast plate all night – a protracted ordeal because a wasp can retract her sting and insert it again, many times. One Oyana example, with wasps still in place, is so small that it would have fitted only a young boy. Métraux (1963) described other examples.

13.4 Honey ants

Honey ants (Section 3.9) live in the Americas and Australasia, and one species in southern Africa; Table 13.4A lists some species, with their locations. These ants were the only source of honey in the very dry, hot plains and deserts where honey-storing bees and wasps could not survive. Brief periods occur when the ants can collect nectar and honeydew and, in Australia, sweet liquid exuding from plant galls on *Acacia* trees. Between latitudes 20°N and 40°N in North America, galls also develop on trees, and native peoples in Mexico and south-western USA obtained honey from ant colonies that fed on them.

During dearths the ants survive by feeding on honey stored in the greatly distended abdomen of certain workers of their colony known as 'repletes' (Figure 3.9a). But honey ants were perhaps man's least rewarding source of honey, and the fact that he sought out and ate them in both Ancient and more recent times is a testimony to his great love of sweetness.

Australia

Honey ants were especially important to Aborigines in central Australia, and these people knew when the honey would be ready for harvesting, and how to find the nests; women and children, especially, dug out the repletes and ate them as a sweetmeat. In 1642 Abel Tasman found women digging for ants in the interior of Tasmania (Australian Bee Journal, 1970), and Spencer and Gillen (1899) described the operation in central Australia as follows. Only a small opening in the ground indicated the entrance from which the central burrow went down. The older women were astonishingly quick at finding these entrances, and at reaching the nests. After inserting a thin stick as a marker, a woman first loosened the ground round the opening with a digging stick held in her right hand; then she alternately loosened the soil, and scooped this out with a hand or a small bowl and threw it out of the hole over her shoulder. She dug a hole just large enough to hold her body to a

Table 13.4A

Honey ants and their distributions

Nests of named *Myrmecocystus* species contain large numbers of repletes.

	W USA	*Mexico*	*Australia*	*New Guinea*	*New Caledonia*	*KwaZulu Natal*
Formicinae						
Myrmecocystus						
27 species, including:						
ewarti	x					
melanoticus	x	x				
mexicanus	x	x				
navajo	x					
testaceus	x					
Camponotus inflatus			x			
Melophorus bagoti			x			
Melophorus cowlei			x			
Plagiolepis trimeni						x
Dolichoderinae						
Leptomyrmex spp.			x	x	x	
L. varians			x			

depth of 2 m or more. She collected the repletes from the nest, and also ant larvae which were sometimes eaten. Her small daughter would be at work close by, copying the mother's actions using a diminutive pick, and so learning 'what will be the main employment of her life'.

Men in Honey Ant Totem groups (Figure 13.4a) performed elaborate ceremonies to ensure and increase the supply of the ants (Spencer & Gillen, 1899). They assembled early in the morning, and decorated their bodies with special twigs and dry red ochre, then marched solemnly in single file, chanting, to a depression in elevated land which contained many stones. Each stone was associated with a honey ant man, and there are many legends about ancestral wanderings of honey ant people. A specific stone which projected above the ground was disclosed to view and taken out of the earth, together with a smaller smooth round pebble which represented honey collected by ants. The older men rubbed the stone reverently, then rubbed it over the pebble and replaced it in the ground. Further stones were brought into play; one that was long, thin and pointed represented the digging stick. Singing continued, and all the men became involved, but throughout the ceremony women had no role except to watch in solemn silence. The leader's body was decorated with a pattern representing the chambers in the ants' nest.

Figure 13.4a Rock drawings from the sacred store house of a group of the Honey Ant Totem in the Warramunga people, Australia (Spencer & Gillen, 1899).

Americas

According to reports in the 1800s quoted by Bodenheimer (1951), various peoples in Mexico and western USA ate honey ants freely and appreciated them very much; they searched for repletes in the nests they found, and took great delight in sucking honey from the abdomen. In Mexico the ants were also pressed and the honey collected for eating at meals. Measurements on *Myremecocystus mexicanus* and other species suggest that a single replete might contain between 0.5 g and 1.0 g of honey. The honey was also applied to bruised and swollen limbs, and 'great healing properties' were ascribed to it; it was also fermented to make an alcoholic drink. Ant honey was regarded as 'delightful' by a number of travellers quoted.

13.5 Solitary bees

Nests of some of the larger solitary bees were hunted for their sweet contents, small though this is. Like social bees, solitary bees belong to the superfamily Apoidea. The female lays each of the eggs in her nest on a ball of pollen moistened with nectar, which provides the hatched larva with all the food it needs until it becomes adult. So the contents of the nest may contain small amounts of sweet and nourishing food, attractive to children.

Mentzel's *Description of the Cape* in South Africa (1787) referred to three types of bees from which honey was collected; one type 'prepared the honey without wax, enclosed it in green leaves no larger than myrtle leaves and concealed it in holes found in stone and clay walls. This honey is delicious but scarce and never obtainable in any quantity ... Children look for it everywhere.' It was probably produced by a species of leaf-cutter bee (*Megachile*), nesting in mortar between the stones of the walls (Anderson, 1985). In northern Mexico a favourite sweet of Pima children was 'fly syrup', a thick yellowish juice contained in mud cells (in the earth) of a bee which was probably a species of *Anthophora*; these bees are solitary but their nests are often in large compact aggregations (Bodenheimer, 1951). Australian Aborigines hunted and ate 'small amounts of honey' produced by stem-nesting bees in dead flowering stalks of grass trees, *Xanthorroea* spp. (Cribb & Cribb, 1976).

Mellitidae and *Andrena* species, which also nest in the soil, were hunted in the Hargita Mountains of Transylvania (Gunda, 1968). Domaćinović (1989) recorded the hunting of nests of unspecified wild bees in several locations in Yugoslavia.

Solitary bees were also eaten. In Sri Lanka the Vedda hunted and ate the large carpenter bees (*Xylocopa* sp.) which look rather like bumble bees and nest in timber or in large plant stems.

Part III

HISTORY OF COLLECTING HONEY FROM OWNED OR TENDED NESTS

Chapters 14-17

14

Ownership of Nests and Nest Sites: General Features, and *Apis mellifera* Nests

14.1 Factors conducive to the ownership of natural nests of bees

So long as the human population remained very sparse, only a tiny proportion of bees' nests were harvested and destroyed, and the opportunistic honey hunting described in Part II was likely to continue unchanged. Part III now deals with the next stages of development, in which bees' nests and nest sites were owned.

Individual ownership of immovable property (as opposed to movables such as herds of animals) probably developed during Neolithic times, among peoples who lived a settled existence and started to cultivate their own land. Such ownership might be heritable, and on the owner's death his property passed to the customary heir or some other person of the owner's choice. Alternatively, an owner might pass on his property during his lifetime as a gift to another person, for instance a new son-in-law. Among any one group of people, ownership rights and procedures relating to bees were part of the people's general ownership rights and procedures.

An important factor conducive to the ownership of bees' nests or nest sites in a certain region was probably the substantial growth of a settled human population, which led to a need for more honey. Land was owned by a people or community, or by an individual, and the owner would in general own the trees or rocks on the land, together with any nests of bees in them. Nest sites in rocks were generally long-lasting, and were often owned by the local community. This was so among the San in Southern Africa for example, and among Djibouti people in East Africa in the 1980s.

A tree cavity, formed when a tree rotted, was a nest site usually owned by an individual. When forested land became more densely populated, tree felling reduced the number of nest sites. Remaining nests and nest sites then became valuable and worth owning. (An even more severe shortage of them led some peoples to make artificial nest sites, cavities in trees, or free-standing hives.) By about AD 1000, the property of a land owner in northern Europe might include 'bee woods' (Section 16.22). A peasant who looked after the bees' nests and harvested honey and wax might also own some of the bee trees on the land – for which he rendered certain services to the land owner, or paid quit-rent.

In unowned land (forest, bush, jungle, mountain or desert), a nest could often be used by any person who found it, and he might then become its owner.

The rest of this Chapter refers to *Apis mellifera*, and Chapter 15 to other *Apis* species.

14.2 Nest ownership in the Mediterranean region and Persia

We know rather little about early ownership of natural nests in the Mediterranean and surrounding regions, probably because in most areas hive beekeeping started in Ancient times. But recent practices are likely to be vestiges of much older traditions. In Lebanon (Yazbek, 1989), the forested mountain lands where bees nested in the rocks were owned by villages, but the nests themselves were not owned, and men from other villages could also collect honey from them. In Becharré, a nest found in a public forest might be marked with a nail to ensure that no one else would touch it. In Turkey opportunistic honey hunting was more usual. (But in the eastern village of Ballica in Ardanuç, Bodenheimer (1942) reported a strict system of ownership of any young trees, or large rocks or caves, which a beekeeper tended in order to place hives in them later.)

In Persia, ownership of a nest found in a tree was usually marked by slashing the bark with an axe, knocking a nail in the trunk, or arranging some stones near the tree. But honey was rarely harvested from the nest because the finder preferred to saw off the log containing it and use it as a hive (Mossadegh, 1993). A nest in mountains or a cliff might be owned, or it might be free for anyone to harvest. For generations, nests found near a village were owned

Figure 14.2a Persian honey collector wearing a climbing belt attached to his climbing rope, Novaygon, Fars province, Iran, 1991 (photo: M.S. Mossadegh).

Figure 14.2b Full equipment of the honey collector in Figure 14.2a (photo: M.S. Mossadegh). *Left to right*: climbing rope of sheep wool and goat hair, and two other ropes; two long-handled iron tools; climbing belt.

exclusively by the villagers, and the honey collected was shared among all their families. Depending on the area and the situation of each nest, at least two men, but preferably four or more, went to harvest the honey. Their equipment (Figures 14.2a, 14.2b) included a rope 8-60 m long, and nails to fasten it near the nest entrance so that it remained steady and did not swing. Honey combs were removed with iron rods mounted on wooden handles of different lengths, and then passed down in a basket. They were carried home in a goatskin or metal container. One group of honey collectors might harvest 6 to 75 kg from one nest, and a total of 60 to 200 kg a year. Inaccessible nests in rocks could not be harvested, and in the summer honey ran down the rock face from them. A few nests might occur together, or up to 15 in Chahar-Mahal and Bakhtiari province in central Persia (Mossadegh, 1993).

14.3 Nest ownership in Africa south of the Sahara

Sources of information on ownership of nests in some widely separated parts of tropical Africa are included in Table 8.1B. Where the finder of a nest site in a tree became its owner, with certain rights over the nest and its contents, his first action was to make his ownership mark near it (Figure 14.3a).

14.31 Methods of reaching nests

To reach nests in high trees, wooden climbing pegs were often knocked into the trunk, and left in place for future use. Other equipment for reaching owned nests included more permanent items than those used for opportunistic honey hunting:

- a specially strong rope;
- a climbing belt made of rope and other materials (Figure 8.4b), sometimes incorporating a seat for use at the nest;
- cross-bars, if not already in position, or an axe to cut steps in a tree trunk.

Similar equipment was used in other continents, for instance in Persia (Figures 14.2a and 14.2b) and Thailand (Figure 15.2g).

14.32 Nests in rocks

Nest ownership existed, and was heritable, among the San who lived in dry areas of Southern Africa where honey bees sometimes nested in rocks, but in

Figure 14.3a Pile of stones marking a nest in rocks, Gandamia plateau, 200 km south of Timbuktu, Mali (photo: I.O. Nordrum). The owner has placed the stones on the flat boulder (immediately below the nest) on which he stands to reach the nest.

general the San were hunter-gatherers (Guy, 1972). In South Africa, a nest found became the finder's sacred property, which he usually marked by a pile of stones heaped up in front, as in Mali farther north (Figure 14.3a). No one might take honey from a nest so marked: 'there have been instances where such an encroachment was punished with death' (Stow, 1905); 'it was a killing matter if you took his nest and honey' (Genge, 1994). Campbell (1815/22) said that in the Hardcastle area of Namaqualand, if San men found that any of their marked bees' nests in the rocks had been robbed, they were likely to carry off the first cow or sheep they came to. They felt that they had the right to the bees on the land, just as some other peoples had the right to keep cows and sheep on the grass. The San right was not usually violated, because others found it better to let them obtain the honey and then to buy it from them.

In Namibia most nests were in rock crevices, and Daunan families owned them. Law required that the owner must close up a nest cavity properly after harvesting honey combs from it, and theft of honey from a nest could lead to bloodshed (Pager, 1972). Nests in rocks along the Molopo river bed in Botswana are still owned (Clauss, 1989).

In 1991 Nordrum found an occupied nest in rocks in Mali, marked by stones to indicate ownership (Figure 14.3a); many other colonies in this area probably died out during the dry period 1983/89. In Djibouti, west of the Horn of Africa, most honey was obtained from nests in rocks which were owned by the people to which the land belonged (Peterson, 1989). Nests in trees were treated differently (below).

Forbes *et al.* (1903) quoted a statement by W.R. Ogilvie-Grant about the rocky island of Socotra, 250 km east of the Horn of Africa. Honey bees were 'met with occasionally in enormous colonies. One particular colony on the lower slopes of Gebel Raggit was formed in a hollow in the rock, and must have contained a vast number of individuals, for they streamed in and out of the fissure in endless columns. These colonies are said to be owned by the natives.'

14.33 Nests in trees

In Djibouti, a nest in a tree became the property of the man who first found it, and he would cut or slash his ownership mark on the tree (Paterson, 1989; Peterson, 1989). When harvesting honey, the flight entrance might be enlarged in order to remove combs, and wood or a stone was later used to make good the enlargement. Owners of such nests said that they left some brood comb behind, and although they did not tend a nest they protected it from ratels (honey badgers) by placing a ring of thistle-like plants round the trunk.

In Zaire, Turnbull (1966) lived with Mbuti Pygmies, hunter-gatherers in the rain forest between the Congo River and Lake Albert. No amount of alternative foods, even meat, could reduce their passion for honey. He quoted one of their songs in translation:

I went to the forest to collect honey.
I went, I went, I went.
I went very far, beyond the big river.
I heard the sound of bees, I saw up high the place of honey.
I said, 'Nobody has enclosed the tree with vine, it is mine; it is my honey.'*
I sharpen my axe, very sharp indeed.

*A vine tied round the base of a tree was an ownership mark.

I cut a vine. I fanned my fire, and put the fire in my basket.
I began to climb; I climbed, I climbed.
The honey was very far. It was honey, real honey, not *apuma*.
I reached it. I fastened the vine, I sat. I put fire into the hole.
I blew. I got much smoke, I drove out many bees.
I chopped, I chopped, I chopped.

People in North Bandundo in Zaire did not specialize in honey collection, but if a man came across a bees' nest when hunting, fishing or getting wood, he marked his right to it by attaching a rag or some pieces of straw in a 'magic knot' at the foot of the tree. This ensured that a protective spirit watched over his right (Svensson, 1990).

The village of Siadombozya in the Gwembe district of southern Zambia had large baobab trees in which many bee colonies nested; they were not strictly owned, but an individual or a group had to report to the village headman before harvesting honey from one of them, so that the community was informed. In Ngamiland, Botswana, climbing pegs freshly driven into a baobab tree showed that all colonies in it were owned (Clauss, 1989).

In Nigeria in West Africa, nests might be owned although many were not. In Oyo state, honey from a nest on a farm might be taken by the owner of the farm, or by someone else with his permission (Mutsaers, 1989b). In Senegal (Gessain & Kinzler, 1975), honey from nests in a field or near a house belonged to the proprietor, and anyone who stole it had to pay a heavy fine. There was no ownership of nests in uncultivated or uninhabited land, and anyone who found a nest in a much frequented area was well advised to collect the honey from it without delay, or someone else could legitimately forestall him. Figure 14.3b shows part of a tree in Senegal containing a honey bee nest which was harvested by the owner every year. After harvesting, he carefully repaired the hole he had made, using stones (Gessain, 1974), which also served as an ownership mark. The Tonga in northern Zululand also blocked up their enlargement of the entrance hole after taking honey (Guy, 1970).

Figure 14.3b Opening made to a nest in a tree by a Bassari in eastern Senegal, in order to remove honey combs each year; it was re-closed with stones (as here) except for a flight entrance (Gessain, 1974).

14.4 Nest ownership in continental Europe

14.41 General practices

An early reference to nest ownership and its strict observance occurs in *Leges Barbarorum*, Frankish and Germanic laws from around the 500s. A person finding a bees' nest in woods, whether in a tree or a rock cleft, had to make three marks (*Handzeichen*) as a sign of ownership. Anyone who interfered with or destroyed such a marked nest was to give double compensation to the owner, and also be punished with twenty strokes.

In Russia it is likely that private property did not exist until the late 900s, but by the 1000s-1100s the laws *Russkaya Pravda* protected both bees' nests and the trees in which they were found (Galton, 1971). Breaking up or burning a nest belonging to a prince incurred the price of a horse as a fine; if the nest belonged to a peasant the fine was only two-thirds as much, and it was less still for an empty nest cavity. In the 1300s-1400s the rich bee woods of Oka were mostly owned by princes, partly because all land not documented as belonging to anyone else was counted as a prince's, and exploited by him. By that time wild colonies in the bee woods were being tended in a form of tree beekeeping, and Section 16.22 deals with nest ownership there.

The following laws applied in the forest area of the Carpathian Mountains which is in present Hungary, Romania, Slovakia, Ukraine and Moldavia (Gunda, 1968). A person who found a 'bee tree' (one containing a nest) and wanted to harvest the honey later – usually on the birthday of the Virgin Mary, 8 September – had to put his ownership mark on it. Anyone who stole honey from a nest in a marked tree would be punished. In the Abaúj region, according to the common law in 1721 the honey from a bee tree belonged to the finder; in 1756 it was stated that he marked it with a nail so that he could find it again. The 1793

law of Borszora village stated that the finder was entitled to take the honey but not to cut down the tree.

In some parts of the Carpathian forests, a new nest was continually searched for (Section 9.31); the finder owned it and put his ownership mark on the tree, whether or not he opened the nest straight away. Where there were relatively few nest sites their locations were likely to be well known, and their ownership was often handed down from one generation to another. Although nest ownership was individual, men searching for nests often worked in a group of 2 to 4, and if two happened to discover the same nest they shared the honey from it. Any one group took care not to cross the path of another group, or to trespass on another group's area. Estimates of the number of additional nests found and taken into ownership by an individual in the course of a year in the Carpathians have been quoted as 10-15, 25-30, and 35.

If a man found a nest containing only a little honey, or if he was short of time, he might put his ownership mark on the tree and leave it untouched until the end of the summer. Nests could be found most easily – and contained most honey – just after the end of the flowering period: at that time bees were seeking scarce forage, and would most readily take honey from a baited bee trap (Section 9.31).

Unless the tree in which a bees' nest was found was a valuable one, it usually became the property of the finder. In the Lápos valley in Romania, a beech or oak, wild apple or pear remained the property of its former owner, and if it was damaged in the course of reaching or getting the honey, half the honey had to be given to its owner.

The laws in the Carpathians also applied among the White Russians, Bashkirs, Finnic peoples of the Volga-Kama region, and Altai Turks. In addition to the Germanic *Leges Barbarorum* (Klose, 1925), laws of Nürnberg in 1350 and Lausitz in 1648, and mediaeval laws of Denmark and Sweden (Linnus, 1939) also governed ownership of nests and related rights.

In Sweden, laws existed in Skåne from the 1100s (Berglund, 1960) and were applied quite extensively in the 1300s (Holmbäck & Wessén, 1943). The owner of forest land had rights over his trees, and a person who owned nests in them had rights over the nests. A swarm could be taken freely only if no one could demonstrate his ownership of it. In recent years in Latvia, if someone found that a swarm had settled in a hollow tree bearing someone else's ownership mark, he fixed a green twig in the bark of the tree and then went to inform the owner – who would treat him to a drink.

Domačinović (1989) described rather similar practices (and ownership marks) in Yugoslavia, and identified the areas where they were found.

14.42 Nest ownership marks

Some nest ownership marks have already been mentioned. The mark used depended on the site of the nest and the tools its finder might have with him. Without tools, he could mark a tree by erecting a pile of stones, re-arranging or breaking a branch or branches of the bee tree, or tying a straw rope or vine round the trunk. If he carried an axe or knife, he might slash the trunk as in Figure 14.4a. A nest in rocks was usually marked by erecting a pile of stones in front of it (Figure 14.3a).

Slovak ownership marks included placing a stone under the bee tree, hanging a dry twig on the tree or breaking down one of its branches; in West Africa an inverted bamboo stem was used (Svensson, 1984). Estonians bound the trunk round with tree bast (strands of the inner bark); Hungarians in the Bakony Mountains tied a straw rope round it. In the Lápos valley, instead of marking the tree containing the nest, a nearby tree might be marked (with a cross cut into the trunk) and a bunch of grass tied in a branch of it – to mislead a would-be thief. What were orginally ownership marks seem subsequently to have become orientation marks to help the finder to locate his bee tree again (Gunda, 1968).

A man walking in the Carpathian forest usually carried wood-cutting tools, and might make the same permanent ownership mark on the trunk of a bee tree as that traditionally used by the family on wooden agricultural implements. In any case, the mark was usually constructed from straight cuts made in the

Figure 14.4a Simple owner's mark on a tree containing a bees' nest, Poland, 1937 (photo: S. Kirkor).

trunk, and in one area (Lövetė) the following were used:

II, X, ╥, ⊦, Π, ΠΙ, ⋌, XX, λ, T.

In the Bereg area a man removed a small section of the bark, and wrote the word *megleltem* [I found it], followed by his name.

Anpilogov (1964) made a detailed study of 396 ownership marks for natural nests (and log hives) used in the late 1500s and early 1600s in Putivl' and Ryl' in Ukraine. He reproduced all the marks in his paper, and Figure 14.4b shows a few of them.

14.5 Nest ownership in Britain and Ireland

England

There were many references to bees' nests and hives of bees in England after the Norman conquest by William I in 1066. Inventories in the Domesday Survey of 1086 mention *mellitarii* (nine at Westbury in Wiltshire and five at Lustleigh in Devon), and Fraser (1958) suggested that these men collected wild honey in the woods. A *custos apium*, guardian or keeper of bees who probably also collected wild honey, was recorded at Stokesay in Shropshire, at Suckley in Herefordshire (where he also owned hives) and, in

Figure 14.4b Some of the 396 nest ownership marks in Ukraine analysed by Anpilogov (1964).

the Boldon Book of 1181, at Wolsingham in County Durham where he held six acres of land for his service in guarding the bees.

William I regarded the whole of England as his by conquest and, to reward his followers and those of the English who submitted to him, he granted and confirmed lands to be held of him as overlord, on certain conditions. These individuals might in turn grant land to other persons to hold them in return for services, and these others might repeat the process (Megarry & Wade, 1975). This feudal structure continued during the rest of the Middle Ages. For hunting, the Norman Kings created large Royal Forests which also included heaths and moorland, and prohibited cultivation (as far as possible) within their limits. Bees' nests on these lands, and honey and wax in them, were the property of the King, and many records survive that relate to ownership of bees and the contents of their nests, and to disputes about this. The following examples are cited roughly in chronological order.

About 1155 the Abbey at Haughmond in Shropshire was given land by Gilbert de Hadnall, who made a special reservation that 'if a servant of the abbey finds a stock of bees in a bee tree in the wood, he shall give up one half of it [the produce] or, if it is not wanted, he can keep the whole of it'.

Carta Forestae (1217 and also 1225) laid down in Item 13 that 'every free man shall have the eyries of hawks, sparrowhawks, falcons, eagles and herons in his woods, and likewise honey found in his woods' (Rothwell, 1975). The King's rights to honey in the royal demesne woods of the Forests, and the rights of others to honey and bees, were also set out. In 1335 the court at Pickering, Yorkshire, indicted Gilbert Ayton of taking a gallon of honey and two pounds of wax out of old tree trunks. He claimed that, by the *Carta Forestae*, 'every freeman shall have ... the honey found within his own woods'. The indictment itself stated that he found the honey in his own woods of Hutton Bushell and Troutsdale, so he asked for judgment in his favour, and obtained it. The above citations are from Pee (1974).

In *The Royal Forests of England*, Cox (1905) gave details of the right of the Crown to bees' nests and the honey and wax from them. In the 1400s the 'collectors' for the different wards of Duffield Frith (near Derby) were instructed 'to take for the King all bykes [nests] of bees'. In Essex in 1489, the lords of the manor of Wanstead claimed the profits of bees, honey and wax in Wanstead Wood, and in Epping Forest: 'If any man do take of the hollow trees any honie, wax, or swarms of bees, ... yee shall do us weet [inform us]'. The lord of the manor of Minstead in the New Forest claimed the honey in his woods as late as 1852. Cox gave many other examples.

Stagg (1979) published many documents relating to the New Forest between 1244 and 1334. 'Foresters of fee' were allowed certain produce as payment for their work, and Pleas of the New Forest dating from 1276 stated that 'the foresters of fee retained for themselves all honey found in their bailiwicks ...'. But others caught taking honey were punished. In the demesne wood of Bolrewode, two men 'took and carried away honey from a swarm of bees worth 3s.'. One man had since died; the other was brought before the court and sentenced to pay a fine of 2s. plus the value of the honey. Annual assessments were made of the value of the honey collected in different districts (bailiwicks); before 1297 these varied between 1s. and 5s. (1s. would then buy 400 eggs or 24 arrows).

The grete herball, published in London in 1526, distinguished between 'tame' honey from hives and 'wild' honey from the woods. In 1517, 'one swarm of bees stayed in a certain oak tree on the land of Richard Squyre [in Devon] now for more than a year and is adjudged to the lord without challenge of anyone'. Place names such as Beeleigh in Essex and Beoley in Worcestershire indicate woods with nests of bees.

No records have been found for Scotland, and perhaps much of the country was too cold for the survival of bees in the wild.

Wales

The early laws of Wales, written in the 1200s, were based on earlier material. The following extracts on the status of bees' nests in trees – and swarms from them – indicate that both were important in the economy of the people. The translation below is by Charles-Edwards and Kelly (1983).

> *Redaction D, the fullest text*
> 9. The value of a colony of wild bees in a wood, 2s. [24d.; the same as a hive, presumably with bees in it]. If it is stolen, and the tree in which it is situated be cut, the value of the tree, together with the value of the colony of wild bees, should be given to the owner of the land; but the finder, if he has shown it to the owner of the land, shall receive from him 4d. and a dinner, or else all its wax.
>
> *In Redaction E only*
> 1. If a cut be made in an oak for the sake of honey, 24d. are paid for making an opening, for the honey and bees 24d., and for one of them 24d.

2. If however, it has been broken and secretly cut down to the ground, 10s. [120d.]
3. If however, a man has found it and shown it to the owner, he shall have a dinner that day and the wax.
10. If anyone's swarm has entered into another man's tree, and the owner of the tree has not allowed him to recover it, it is permissible for the owner of the bees to take possession of his swarm after a year and a day, provided that the honey be divided between them into two [equal] shares.
13. No one should place a cross [ownership mark] upon a tree belonging to someone else on account of bees.

A vivid and intimate tale has come down to us from the 1400s in an unpublished Welsh poem *Cywydd yr bidafe* (Verse of the wild bees' nests). The setting is the Vale of Neath, a broad valley of farmland in South Wales which was by no means remote and where hive beekeeping had probably been practised for centuries, but honey was still being harvested from natural nests. Ieuan Gethin addressed the poem to his overlord Sion ap Rhys, whose servants had taken honey from bees' nests in trees on his farm land. I am indebted to Dr W. Linnard, and to Dr A.E. Williams for the translation. There are many more lines than those quoted below.

Splendid Sion ap Rhys, gentle, who breaks spears:
I am making a serious complaint
That you, in spite of the agreement between us,
Are destroying my bees' nests.
By God, your servants ...
They are stealing a portion of the honey ...
By God and Jesus, forbid Llywelyn,
The dark man, your servant ...
The bee-hunter, early in the morning
Is like a fly, searching the trees
With his little axe ...
a hundred gallons
Will have been stolen by these locusts ...

Finally, Ieuan Gethin appealed to the sheriff:

The sheriff with bright cheeks,
Sir William, with his clean faultless sword,
Who knows the law wisely
To interrogate the fly about searching the tree.
A master on feast days, one who is beloved by me,
Insist on compensation from all of them.

Account books of estates at Hope in Flintshire listed honey 'of woodland bees' in 1349/50, and those at Llanstephen in Carmarthenshire listed 'forest honey' in 1410/11. But in 1500/01 in Llanstephen, 'of forest honey and wax this year, nothing, because there is no wood (*silva*), neither are the trees grown where such honey and wax may be had' (Crane & Walker, 1985/86) – deforestation had removed the trees in which the bees nested.

Ireland

The early laws of Ireland, written in the 600s/700s and also based on earlier material (Charles-Edwards & Kelly, 1983), were much less concerned with bees' nests. But they set out the legal position when a nest in owned (enclosed) land was found by someone other than the land owner:

> 47. The man who finds a tree with bees in a lawful green [enclosed land]: ... one half [goes] to the man who finds it, the other half to [the owner of] the green where it is found.

14.6 Nest ownership in the Americas and Oceania

Nests of introduced European *Apis mellifera* were present from the 1600s in North America. Although many references were made to honey and bee hunting, there are few indications that nests were owned. Section 12.21 mentions a lawsuit in Massachusetts in 1641 about ownership of a colony in a tree. In Wisconsin, the finder of a nest carved his initials on the bee tree (a sign usually respected by unwritten pioneer law), and in Waukesha County in 1841 the finder could not cut the tree without the consent of the owner – although if the owner cut the tree, the finder had no right to the honey. Farther north, in British Columbia, Canada, Turnbull (1958) referred to slashing a cross in the bark of a tree.

In many parts of North America honey was so plentiful that it was taken without regard to ownership (Schorger, 1967/68). Natural nests were 'free for any body' in Pennsylvania in 1707. An individual found 32 bee trees in a week in Missouri in 1818/20 (compared with 10-35 during a year in the European Carpathians, Section 14.41). In Louisiana between 1820 and 1860, 'neighbourhood social gatherings' were organized when bee trees were cut down.

In Australia, where European bees were introduced later, most references to natural nests are more moderate, although in some areas they con-

tained much honey, and the same was true in New Zealand (Sections 12.5 and 12.6); there is little suggestion of ownership of nests. No records were found for Pacific islands.

14.7 Ownership of *Apis mellifera* nests in Asia east of Persia

According to Linnus (1939), honey hunting was an ancient occupation of Turkic-speaking Shor people in the forests of the Altai Mountains in Siberia (Russia) and Khazakhstan, and nest ownership developed from the honey hunting. When searching for nests, the Shor and several other Turkic-Mongolian groups used urine as a bait for the bees, as they did for reindeer. They soaked moss with fat and human urine, closed it up for a few days in a bark vessel, and then set it out in the forest and burned rotten wood beside it. The bees flew to the moss and, 'intoxicated' by the urine, returned to their nest slowly and could be followed. A skilful man might find twenty nests in a spring season; he put his ownership mark on a tree containing one, and could harvest 32-48 kg of honey from each at the end of the summer (Gunda, 1968).

Section 36.41 describes the transport of European *A. mellifera* from Russia and Ukraine to parts of Siberia during and after the 1770s. In 1884 Radloff reported that there were many 'bee swarms' in Siberia, and their honey was taken by Tatars and sold to Russian merchants. He was told that bees 'were not present earlier' in the Altai but were first brought by Russians, and they had since 'gone wild and increased endlessly'.

Section 14.2 refers to countries near the Mediterranean which are in Asia. *A. mellifera* was not introduced east of them until the late 1800s, and colonies nesting in the wild do not seem to have been important.

15

Ownership, and Rights of Using, Nests and Nest Sites in Asia East of Persia

15.1 The relative importance of different honey bees

Harvesting honey and wax from nests of Asian honey bees developed beyond opportunistic honey hunting (Chapter 10) for the three species *Apis dorsata*, *A. cerana* and *A. florea*. Ownership of nests, or the right to harvest from them, seems likely to have been vested in an individual if one person could do the work unaided, as with isolated nests of *A. cerana* or *A. florea* or those of *A. dorsata* that were easy of access. But if a number of people had to co-operate, as with *A. dorsata* nests difficult of access, ownership and rights were likely to belong to a group or a whole community. An aggregation of many *A. dorsata* nests on a high tree or a rock face was an important property – and so was the tree or rock face itself, because migrating swarms were likely to build nests on it year after year. At high altitudes in the Himalayas, *A. laboriosa* replaced *A. dorsata* (end of Section 3.4).

The nest of *A. florea* was small, and its ownership was generally much less important except in areas where there was no other honey bee. The finder could easily cut off the thin branch supporting the single-comb nest a few metres from the ground, take the whole comb away (with the bees), and support it in a convenient place near the house.

Figure 15.1a indicates some of the localities referred to in this Chapter that were important in the traditional exploitation of one or more of the honey bees.

15.2 Nests of the giant bee *Apis dorsata*

15.21 Some noteworthy practices

Perhaps because of the large amount of honey obtainable from a nest, the grouping of many nests together, and the dangers associated with reaching them, harvesting the single-comb *A. dorsata* nests (see Figure 4.2d) was subject to many rituals, taboos and customs, which were punctiliously observed. These had many common features in different regions, suggesting an early origin for them.

Table 10.2A gives information about types of harvesting from *A. dorsata* nests; these were on rock faces in at least two-thirds of the regions listed, and on trees in others. Rock paintings in India (Table 10.2B) show honey collection from both types of site, and some of the earliest paintings date from the Mesolithic period. Implements shown are very similar to those described in this Chapter:

- ladders or ropes (Figures 10.2b, 10.2d, 15.2c, 15.2d).
- wooden sword (15.2c,C); long pole fitted at one end with a wooden knife (15.2d) or with several prongs (10.2b) – compare also the child's *masliya* (15.2b).
- collecting bag or basket (10.2b, 10.2d, 15.2c, 15.2d).

The climbing rope had to be particularly strong, and was often made from special materials. A taboo on the use of metal for cutting the combs was almost universal among traditional honey collectors. In this specialized and dangerous operation, passed on from father to son through many generations, it may have been considered necessary to adhere strictly to inherited custom, and metal was not yet in use in Mesolithic times. Also, a rope could be cut accidentally with a metal blade. A wooden knife was commonly used (bamboo in north Vietnam) or – for instance in parts of Malaysia – the shoulder blade of a cow (Mardan *et al.*, 1989).

Honey collectors made preparations during daylight, but many approached the nests only on moonless nights. The bees cannot see to fly if the moon is less than half full (Dyer, 1985), so fewer stings were likely to be received then.

In general the bees were smoked when honey was collected, but some peoples used small embers from a torch to lure the bees away from the nest.

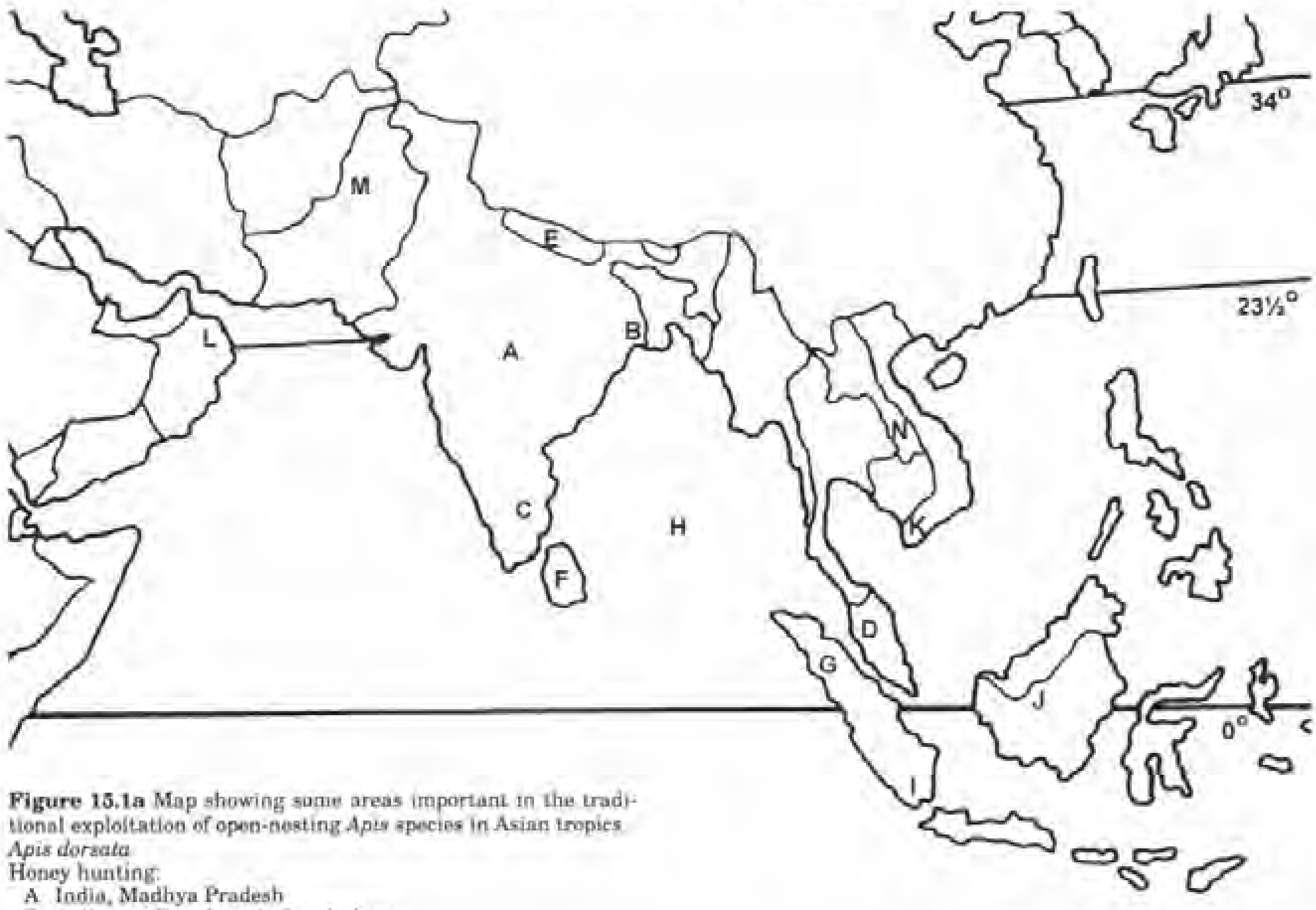


Figure 15.1a Map showing some areas important in the traditional exploitation of open-nesting *Apis* species in Asian tropics
Apis dorsata
Honey hunting:
A India, Madhya Pradesh
B India and Bangladesh, Sundarbans
Honey collection from owned nests:
C India, on rock faces, by Chenchu
D Malaysia, on high trees
E Nepal, on rock faces, Himalayas, *A. laboriosa*
F Sri Lanka, on rock faces
G Indonesia, Sumatra, Stabat
Tending nests, and beekeeping:
H India, Nicobar and Andaman Islands
I Indonesia, Sumatra, Lampung province
J Indonesia, Kalimantan, Kapuas lake region
K Vietnam, Mekong delta
Apis florea beekeeping:
L Oman
M Pakistan, Indus valley
Also *Apis cerana* kept in tree cavities:
N Laos, Sekong province

Use of bee pacifiers

A few peoples pacified the bees with certain plant materials, and Table 15.2A gives details of some plants used in the Nicobar and Andaman Islands in the Bay of Bengal (Figure 15.1a,H) and elsewhere; some may have been used since early times. In the Islands negrito (pygmy) peoples – of whom there are now only a few hundred individuals – used extracts of a number of plants (Cipriani, 1966) and were able to collect part of an *A. dorsata* comb containing honey and leave the colony intact, as described in Section 18.1. By tradition the Onge on Little Andaman used leaves of a local tree *Orophea katschallica* (Dutta *et al.*, 1983, 1985); they smeared their bodies and hands with the sap mixed with saliva, and also chewed leaves and spat them on to the comb. The bees thereupon flew away from the comb and did not sting. The tree grows on many of the Nicobar islands, and the Jarawa people on some other Andaman islands also used its leaves, as did the isolated Shompen on the southernmost Great Nicobar who are believed to have learned its use independently. Other plants used similarly were *Amomum aculeatum* (Figure 15.2a) and *Zingiber squarrosum* (Dutta *et al.*, 1983, 1985). *Alpinia manii* was used in one or more other Andaman Islands; the sap sprayed on the bees repels them by its 'obnoxious odour' (Man, 1883). Vasudeva Rao and Chakrabarty (1985) described the use of this plant and of *Amomum fenzlii*.

Piper celtidiforme leaves were used in the Philippines (Adey, 1985), and smoke from burning *Artemisia* in Nepal (Oppitz, 1990, 1991).

Figure 15.2a A hand smeared with leaf sap from *Amomum aculeatum* touches an *Apis dorsata* comb in S. Andaman Island to repel the bees; a squeezed stem is also carried on the shoulders (Dutta *et al.*, 1983).

In Buki Tinge in west Sumatra, a collection was made of certain herbs, spices and leaves of plants from the rain forest, and wrapped in the spathe of a coconut flower. The honey collector lit one end, and from the other end blew the smoke lightly over bees on the comb (Allen-Wardell, 1992).

15.22 Nests on sheer rock faces

The earliest records are from southern China during the Chin dynasty, between AD 265 and 290, when Chang Hwa wrote (Kellogg, 1968):

> In far off mountains and out-of-the-way countries of the South honey and wax are found. These stick to dangerous and perpendicular cliffs which are impossible to climb. To get the honey one must sit in a chair or in a basket which is tied to ropes and lowered by others over the face of the cliff. After the bees have left the place, some of the wax still sticks to the face of the cliff ... The next spring the bees come back and make their nests as usual. People possess the place and call it 'Honey Fort'.

Kellogg also quoted from a history of the Yüan dynasty (1260-1368), commenting that the collection of honey from 'wild bees' was quite common, and was a source of income for the people:

> Fu Chu, when he became magistrate of the district (in Chekian Province), opened to all the people the privilege of collecting honey from the honey cliffs of the district, which all former governors had taken as their exclusive right.

Table 15.2A

Some plants whose extract or smoke was used to pacify or repel the honey bees *Apis dorsata* and *A. cerana*

Most data are from Crane (1990a) and references are cited in the text of Section 15.2 here. For *A. mellifera* see Tables 8.6A and 8.6B.

Plant name and family	*Uses, effects*	*Region (Reference)*
Apis dorsata		
Orophea katschallica Kurz (Annonaceae)	chewed leaves smeared on body, and spat on comb, as repellent	Little Andaman and other islands
Amomum aculeatum Roxb. (Zingiberaceae)	sap from crushed stems and leaf stalks used as repellent and tranquillizer*	South Andaman; see Figure 15.2a
Amomum fenzlii Kurz (Zingiberaceae)	probably as other Zingiberaceae	Great Nicobar Island
Alpinia manii King (Zingiberaceae)	ditto	Andaman
Zingiber squarrosum Roxb. (Zingiberaceae)	similar effect to *A. aculeatum**	Little Andaman
Artemisia sp. [?*lactiflora*] (Compositae)	smoke from burning plants used on body before collecting honey	Gharti people, Nepal
Albizia amara (Leguminosae)	paste made from leaves	Tamil Nadu, India (Nath *et al.*, 1994)
Piper celtidiforme Opiz (Piperaceae)	leaves rubbed on body to prevent stinging	Philippines
Apis cerana		
Artemisia sp. [?*lactiflora*] (Compositae)	smouldering dried plants repelled bees	China
Ocimum sanchum (Labiatae)	leaves smeared on body	Madras, India
Shorea floribunda G. Don. (Dipterocarpaceae)	bark placed in toddy pots repelled bees	Thailand
Zingiber sp. (ginger)	'a little ginger' chewed to keep bees from the face	Assam, also Madras, India

For plant extracts tested experimentally, see Kumar *et al.* (1986).

* ineffective with *A. cerana*.

But in another part of the Yuan history:

> Jen Fang, the famous essayist of the time, when he became magistrate of the Sing Au district, stopped the people collecting wild honey, as many had met their death by venturing to climb the dangerous cliffs for it.

The recent descriptions below are arranged according to region, roughly from south to north, and procedures are described in detail for the Vedda in Sri Lanka. Other peoples proceeded similarly, with certain variations which are noted. Usually, a flexible ladder or rope was let down from the top of a cliff, and the man – balanced on the ladder – collected each honey comb by cutting it off the rock face.

Vedda in Sri Lanka

The Vedda were probably Dravidians from southern India, and may possibly be related to the people who became Australian Aborigines. They are now confined to the centre of the eastern part of the island but were much more widely spread in past centuries.

The following description of honey collection from a sheer rock face is based on Spittel's (1924). The men planned to collect five large combs at Panihela during the night. On the previous morning they assembled at the rock to get canes and vines for making the ladder. Two canes were cut, 7 to 10 m long and about 2 to 3 cm thick, dragged up the hill at the top of the rock face, and laid out. Knotting the end of one cane to a tree, they split it in half. A man standing at the open end held the halves apart, while two others stood in between and constructed strong rungs at intervals of 60 cm, using creepers which were first looped round each half of the cane and then bound together with a running twist. If a single cane was not long enough for the ladder, its ends were doubled up and tied into loops which were then engaged with similar loops of another split. The ladder was finished off by overlapping the free ends in the form of a U, and binding them together.

A light pole about 1.8 m long was made pointed at one end, and forked at the other by splitting crosswise to make four pointed prongs which were kept apart by binding wedges between them; Figure 15.2b shows a child's toy version of this *masliya*. Four torches were constructed which would give the maximum amount of smoke: dry grass, leaves and bark were enclosed within an outer layer of green leafy twigs. Both pole and torches had long loose loops attached to them, by which they were slung on the man's arms when not in use. Lastly, there was a

Figure 15.2b Vedda child's toy *masliya*, a long pole with 4 prongs at one end, used in make-believe games of collecting honey from *A. dorsata* nests in Sri Lanka (Seligmann & Seligmann, 1911).

deerskin bag to receive the honey combs; when in use this was referred to as the 'devil's mouth' to propitiate the spirits, who might otherwise become angered and send the honey collector or 'cutter' to his doom.

A heap of firewood was collected at the bottom of the rock face to help in smoking the bees, and another at the top to protect the guardian of the ladder. He was the brother-in-law of the cutter, who by custom was the only person *not* eligible to marry the widow if the cutter were killed. When darkness fell, a great fire was lit at the foot of the rock and fed with green leaves to produce a large volume of smoke. When the people below heard the stir this caused among the bees, their excitement increased and they sang: 'The bees, the bees, the bees! Pile the fire, pile the fire, pile the fire! Ho, the bees run!' '*Giddi, giddi, giddi, rung, rung, rung*' they jeered, in imitation of the flight. Meanwhile the fire at the top had been lit, and two smoking torches were lowered towards the bees' nests. The air was heavy with the hum of angry bees.

The ladder, firmly secured to a tree or rock at the top, was now let down, accompanied by a propitiatory incantation to the demons and ancestral spirits of the rocks; this would make the cutter's hand grip strongly, and enable his feet to cling to the rock face. With smoking torches looped to his forearms, and the long pole on his shoulder, his hair dishevelled over his face to protect eyes and nose from the bees, the cutter disappeared over the edge of the cliff into the darkness and the smoke, gripping the long pole with a single hand. When he reached the level of the nests he signalled for the deerskin bag to be lowered to him, and he secured it to the ladder. Thrusting one leg between two rungs – with his foot on the lower one, his bent knee against the upper one and his head between two others, so that the back of his neck was braced against a rung – he was free to use his hands. First he smoked the nests, covering them with the torches (usually mounted on the pole), to drive away the remaining bees. Then, slinging the torches on his forearms, he took hold of the pole, and used its pointed end to cut horizontally through the comb, separating off the lower part with brood which he did not want, but which the bees defended strongly. He next cut the upper part of the comb containing honey into vertical sections; loosening each from its attachment, he removed it with the pronged end of the pole, and shook it into the bag at his knees. He dealt with

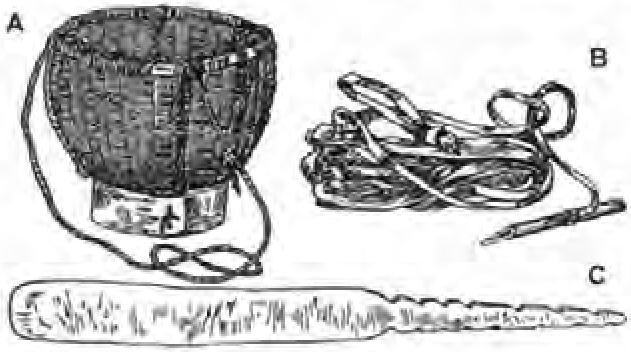


Figure 15.2c Chenchu equipment for collecting *Apis dorsata* honey (Fürer-Haimendorf, 1943). **A** Close-woven honey basket, smeared inside with resin; **B** *Nara tarpa*, a broad strand of fibre with a bamboo spike at one end; **C** Wooden sword for cutting the comb.

other nests similarly. The operation at each nest was somewhat similar to that carried out by the honey collector in Nepal shown in Figure 15.2d. According to Nevill (1887), the combs were cut off with a 'wooden sword' which is likely to have been similar to that in Figure 15.2c(C).

As he worked, he sang the cutter's song, and the rocks around re-echoed to it. When the bag was full, he released it from the ladder and shouted to those above to pull on the attached rope. This lifted the bag up in a series of short jerks, and the cutter helped from below as he climbed up. Finally he clambered over the top – 'sweating, exhausted, honey-bedaubed, bereft of all the stamina that had sustained him so long, and covered in stings. He threw himself down, and his wife and perhaps a friend or two grouped round him and with pitying words picked off the stings. Impatient of this, he smeared himself with sand so that the ants could not worry him, and was soon asleep.'

Sometimes the nests were beneath a rock overhang, in which case the honey collector could reach the combs only by swinging to and fro 70 m or more above the ground.

Seligmann and Seligmann (1911) studied some of the forest Vedda. A community of Bandaraduwa consisted of one to five families who shared the rights of hunting over a tract of land: they collected honey from the rocks, fished its streams, and used its rock shelters. Each family was the recognized owner of one or more rocky hills on which there were *A. dorsata* nests, but the whole community joined to collect honey from each hill, and the honey was always equally shared. Among several groups of Vedda, when a woman married a man in another area, her father (in one case both parents) gave the new son-in-law a piece of land containing a number of the nests, for example a specific hill. In one instance 'the gift carried with it the sole right to take rock honey on the hill, where there were six colonies'. When approaching death, a father would divide his land equally among his children, but an earlier gift to a daughter's husband would be counted as her share.

The same authors described how boys in a Vedda community were systematically taught 'honey getting' by playing at it.

> A boy tied a bundle of green leaves together with creeper, then took a toy pronged rod [Figure 15.2b], an arrow to cut the comb, and a broken gourd to represent the deerskin honey container, and copied the adult's procedures at the nest. He beat his chest and sides as though driving off the bees, and directly he reached the ground rushed into the jungle to escape from them, all the smaller children imitating him with great glee.

Peninsular India

The Chenchu are an aboriginal people living in a jungle region of Andhra Pradesh and Hyderabad in south India (Figure 15.1a,C). Fürer-Haimendorf (1943) made a detailed study of their lives, including their honey collection. It seems that, according to their laws of property and inheritance, the *A. dorsata* nests belonged to the community on whose land they were built, as among the Vedda. The author found many other similarities to the Vedda and mentioned four times that the man most trusted to keep the climbing rope secure at the top of the cliff face was the honey cutter's brother-in-law. Figure 15.2c shows Chenchu honey-collecting equipment; the most valuable item, the honey basket, was characteristically a man's personal possession (like a tool or weapon), and was handed down from father to son to grandson. The *nara tarpa* (B) was sometimes thrown like a harpoon into an inaccessible comb, so that the honey flowed down the fibre into a receptacle on the ground below.

Fürer-Haimendorf (1948) also described the collection of *Apis dorsata* combs from high trees and rock faces by the Gond in Madhya Pradesh, central India. The honey collector wrapped himself in a blanket, and carried a herb to protect himself from the bees. He climbed up a ladder made from creeper, carrying a smoker of burning grass tied at the end of a very long bamboo pole. A somewhat shorter length of bamboo (1.6 m) had a large wooden spatula at the end for scraping the comb into a basket. Some equip-

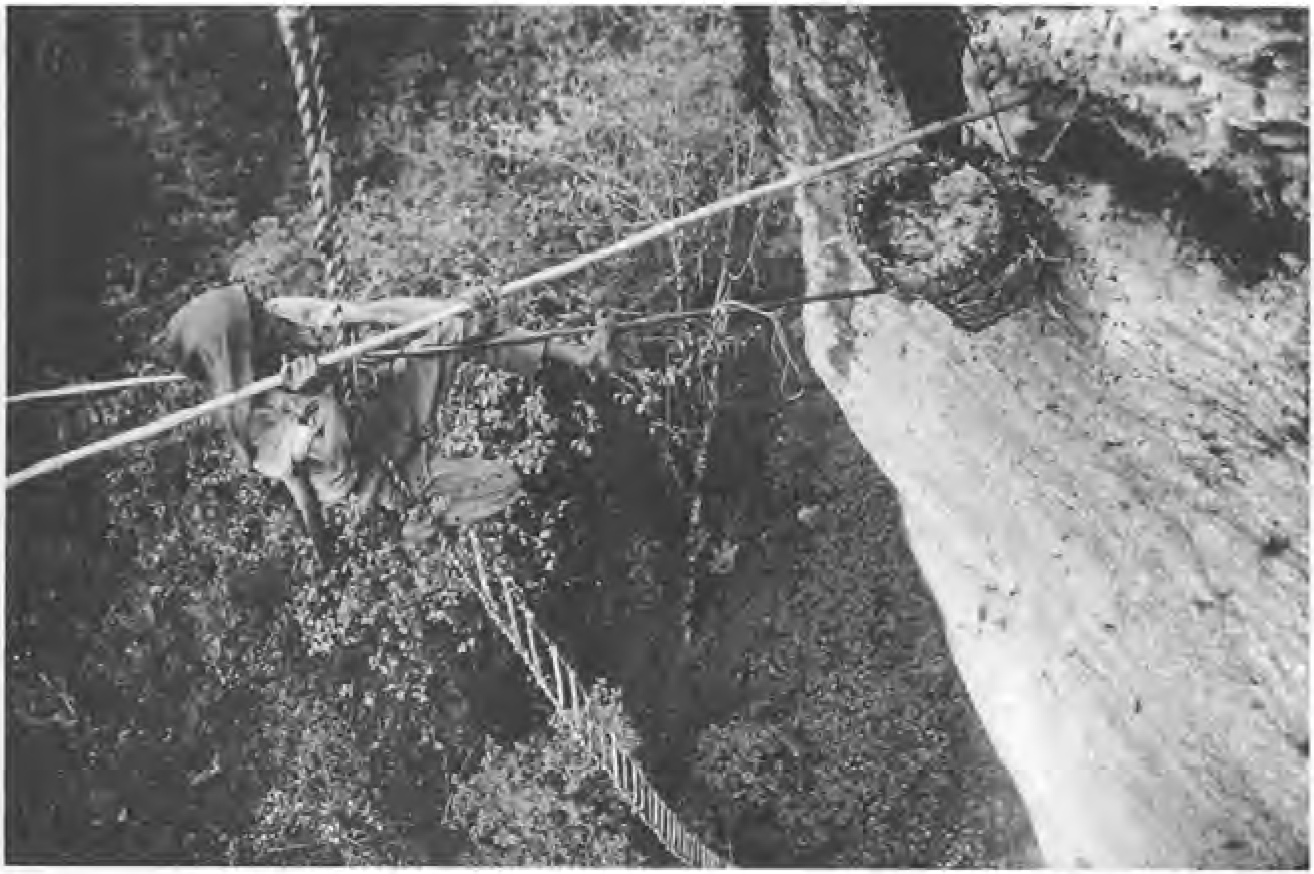


Figure 15.2d A Gurung honey collector at a nest of *Apis dorsata/laboriosa* on a rock face, Nepal (photo: E. Valli). He is breaking off a piece of comb with the pointed end of one pole, and uses the other pole to support a bamboo basket (lined with goatskin) where it will catch the comb.

ment used by the Gond is in the Museum of Mankind in London (Weir, 1973).

A report by Keystone Press (1994) described honey collection in Tamil Nadu, from nests on rock faces up to 100 m above the ground, and also on high trees. Procedures were similar to those already described, and at the top of the cliff the security of the rope was also guarded by the brother-in-law of the man collecting the honey. Young brood was eaten with the honey.

Gurung and Gharti in Nepal

The Gurung live on the southern slopes of Annapurna and Lamjung Himalaya (E in Figure 15.1a); their language belongs to the Tibetan group. The description of their honey collection below (Strickland, 1982) almost certainly refers to *A. laboriosa*, a larger species that lives at altitudes above 1200 m (Section 3.4). A fire was built at the base of the rock, so that the smoke dispersed the bees upwards from the lower edges of their combs. A ladder, made from twine of the cortex of mountain bamboo and soaked in water to make it flexible, was suspended from the top of the cliff, tightly secured to trees at both upper and lower ends. The man collecting the honey descended the ladder, with a pole about 3 m long that had a sharp wooden blade attached to one end; at the other a cord was tied that reached to the top of the cliff (Figure 15.2d). A bamboo basket was suspended from another rope, its position being guided with a rope held by people on the path below. When a comb was cut off with the blade on the long pole, the basket was guided to catch the pieces as they fell down; when full it was lowered to the ground, emptied, and used again. Parts of the combs were left, and within a month the bees would rebuild the combs and store honey.

Splendid colour photographs and also film of a Gurung group collecting honey from nests on sheer rock faces were produced by Valli and Summers (1988a, 1988b). The group consisted of nine men; each had learned the techniques from his father and

had inherited from him the right to collect honey (1988b). The leader of the group was older and more experienced, usually a shaman who was believed to have direct access to the gods or spirits. He decided when to start and finish collecting honey in spring and autumn, and only he descended the ladder to the nest (Figure 15.2d) after the requisite rituals and prayers.

The Magar people lived in the remote Dhaulagiri region of the high Himalaya in Nepal, north-west of Pokhara. Members of one clan only, the Gharti, collected honey combs from nests on rock faces (Oppitz, 1990, 1991), and their exclusive right to do this operated within ancient matrimonial exchange groups of the clan. In general, Gharti methods were very similar to those of the Gurung. If one comb was only partly broken off, the rest was left for the bees to rebuild, but this occurrence seemed to be accidental rather than intentional. Vessels in which the combs were collected sometimes overflowed, and the men below retrieved what they could from the ground.

Many observances were considered necessary before going to collect honey or to hunt animals. A man fasted, and then ate without any contamination. There must have been no recent death among his near relatives; his wife must not be menstruating or pregnant. It was believed that the bees had a keen perception of impurity in men, and reacted to it by stinging. So before setting off, honey collectors 'purified' themselves in smoke of burning *Artemisia* (a 'smouldering' plant of this genus repels *A. cerana*, Table 15.2A). At the foot of the rock face where the bees' nests were found, offerings were made to the spirits that guarded the bees, the spirit of the forest, the special spirit of the hunt, *thiri zyea*, and the deity of the mountains, *sidha*. The offerings consisted of strips of cloth fixed on bamboo stems, and food made from rice and yeast. Certain numerical rules were important. The number of combs harvested on one expedition might be 1, 2, 4, 6 or 8, but not 5 or 7, since these were unlucky numbers; 3 was very ill-fated, and harvesting 3 combs could bring fatal consequences, so a group of 3 nests would probably be left untouched. The spirits of the hunt punished any non-observance as a transgression against the honey collector's right of ownership of the hunting ground, because the cosmic balance of nature had been upset.

Irrespective of who went on a Gharti honey-collecting expedition, the honey obtained was distributed among all families of the clan. The average total amount was about 2.3 tonnes a year in 1990; divided among 46 households, each share would be about 50 kg. Some wax was used for lubricating weaving shuttles, but the Gharti used sandalwood, not wax, for lighting, and most wax was exchanged for manufactured goods at a market in the south.

15.23 Nests on high trees

Great forests in south-east Asia provided nest sites for *Apis dorsata* on high trees. Examples are given here (again, roughly from south to north) of hereditary honey collection still carried on from nests in Indonesia (Sumatra, and Kalimantan in Borneo), Malaysia, Thailand and the Andaman islands; locations are marked in Figure 15.1a.

Sumatra, Indonesia

Goldsworthy (1978) described in detail many honey-collecting ceremonies, and the songs associated with them, on the east coast of north Sumatra – in particular near Stabat in 1973 (Figure 15.1a,G). The people's music was closely related to their magico-religious beliefs, and – in common with most music used during work – it made dangerous tasks safer and boring ones more tolerable.

Only an experienced shaman had sufficient knowledge of the spirit world to cope with the spiritual and physical dangers of actually collecting the honey. He had to propitiate the spirit of the tree, whose territory would be invaded when the honey was taken. Physical dangers might include encountering a bear or tiger in the neighbourhood of the tree, falling to death while climbing, being stung by a large number of bees, and suffering skin irritation from the tree's sap.

The short honey season occurred when durians (*Durio zibethinus*) were ripe. The people collected honey on a moonless night, from certain trees that had been used regularly for many years. One night they gathered under a *Koompassia excelsa* (Leguminosae) containing 130 nests. The lowest nests, on the first branches, were 40 m from the ground, and the only access was up the smooth vertical trunk. Two shamans were responsible for taking the honey; the elder, Pak Saleh, acted as the spiritual leader, and the younger, Pak Samin, did the active work of climbing the tree and collecting the combs. Other participants raised and lowered the honey bucket. Pak Saleh had learned the work from his father, and all three of his younger brothers were also honey collectors.

Figure 15.2e shows a ladder in place up a tree, and a shaman working at one of seven nests, with his torch in one hand and his cutting knife in the other. Below, the other shaman stands clear of a cloud of

Figure 15.2e Collecting *Apis dorsata* honey in central Sumatra, Indonesia (Hasselt, 1882). See text for details.

bees, ready to receive the conical basket when it is full. The shaman had climbed the tree carrying a slow-burning torch (Figure 15.2f,B), and when he reached the nest he repeatedly struck the torch on the branch supporting the nest, so that small burning embers cascaded in a shower to the ground below, and he sang all the time to induce the bees to leave their comb and follow the red embers, which they did. Goldsworthy (1978) quoted and interpreted the songs that accompanied the procedures, including those to propitiate the spirit of the tree in which the nests were built.

Customs relating to ownership of bee trees in central Sumatra, and agreements for dividing the wax and honey harvested (Hasselt, 1882) tally with what Kehding (1882) recorded for Malaysia. Tools (Figure 15.2f) might be of wood, bamboo or cane – but not metal which would offend the spirit of the tree.

Kalimantan (part of Borneo), Indonesia

In the Kapuas lake system in western Borneo (now Kalimantan, J in Figure 15.1a), Lijnden and Groll (1851) reported honey and wax collection from *A. dorsata* nests, with the comment that very much wax was collected by people (probably Melayu, see Section 18.2) who lived near lakes Seriang and Loewar. A tree with bees was owned by either the land owner or the person who first found the nest and put his ownership mark on the tree.

Lahjie and Seibert (1990) described honey collection in the interior of east Kalimantan, where *A. dorsata* nested in *Koompassia excelsa*, as in Malaysia and Sumatra. The trees were usually owned by families, and the children could inherit ownership and rights of collecting honey. Ceremonial leaders, or a group living in a particular longhouse, could also own rights. Honey was harvested only from trees with five or more nests, and one tree might yield between 70 and 400 kg honey. A thin line was thrown over the lowest branch of the tree in order to fix a climbing

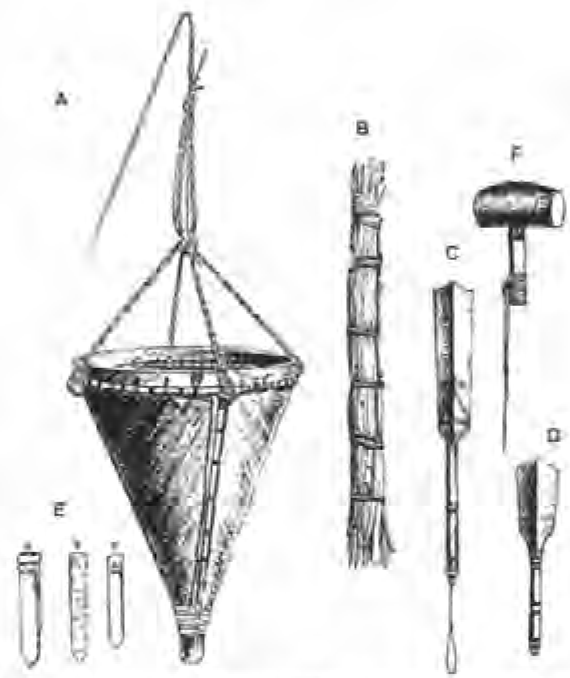


Figure 15.2f Tools used by honey collectors in central Sumatra (Hasselt, 1882). **A** Conical basket for comb, made of bark and rattan, attached to a braided rattan rope; **B** Torch of bark, that burns well and gives many sparks, without much flame; **C, D** Wooden knives for cutting comb; **E** Bamboo pegs for knocking into the tree to form a ladder: (a) the thickest for the first rung; (b, c) for the second and subsequent rungs; **F** Mallet of very hard wood for knocking in pegs.

ladder on the smooth trunk. Alternatively, ironwood pegs were driven into the trunk at intervals of 0.5-0.7 m, but hit only twice 'in order not to offend the spirits of the tree'. (Lao people reckoned that more than three blows would drive the peg into the heartwood of the tree and so damage it.) Honey was collected in a bamboo container, which was lowered to the ground counterbalanced by a weight (about 5 kg) made from *Koompassia* wood.

Malaysia

In 1988, the Agricultural University of Malaysia organized a meeting between about 50 professional *A. dorsata* honey collectors (*tualang*), who were members of groups living and working in different forest areas of the country (Mardan *et al.*, 1989). Each group was interviewed by a series of specialists who recorded information on the techniques and equipment, harvests and economic return, customs and beliefs, and the bees themselves. I learned the following at interviews I attended.

A village usually had 1, 2 or 3 groups of honey collectors, each with an experienced leader who was often an older man, and usually 4 to 7 others – some of whom would lead their own groups later on. *A. dorsata* swarms migrated into the area, and built nests in the same trees year after year, on average about 35 nests in a tree. According to the unwritten *tualang* regulatory system, each group in a village 'owned' certain bee trees in an area; see also Kehding (1882). By local custom each group worked only the trees it owned. Like honey collectors in other countries, they had an extensive knowledge of the biology and habits of the bees.

Many of the trees were 50 m in height, and pegs were used for climbing them; Figure 15.2g shows cross-bars, an alternative in Thailand. If ladders were used they were made of wood that did not easily split. Honey collection followed a lunar calendar and was done only on moonless nights. The honey collectors learned from their grandfathers, and believed in teaching the next generation so that the traditions would continue. Rituals and customs were rather similar to those in Sumatra described above, including the production of embers to attract the bees to leave the comb. In both countries there is now a strong Islamic influence in the beliefs and incantations, although many are an inheritance from earlier animism and (here) Hindu tradition.

One very experienced group – who clearly much enjoyed their work – came from Trengganu on the east coast. A collecting expedition might last for one or two days. The area containing the group's bee trees was cleared in daylight, but work at the nests was done only in darkness. There were five trees from which honey could be collected every year: between 72 and 125 nests on each, about 50 m from the ground. The men might collect honey from 78 nests in nine hours; working at such heights needed great care and was very tiring, and if a man felt so tired that he might fall asleep he tied himself to the branch before resting.

Figure 15.2g The top quarter of a ladder, formed of cross-bars whose centres are fixed to the trunk of a *Dipterocarpus* tree containing *Apis dorsata* nest sites, Chantaburi, Thailand (photo: E. Crane).

Opportunistic honey hunters (*camuk*) were customarily given permission to work a tree with only one or a few nests, and the head man of the village was informed.

Lao people in northern Thailand

Bodenheimer (1951) quoted Cowan's 1865 report on these people. The work of collecting *A. dorsata* combs was hereditary; it was believed that the men who did it were immune to stings, and that the immunity passed down from father to son. Thus all the honey in a district was collected by one or a few families.

The procedure was a variant of that in the forests of Malaysia and Indonesia to the south. On the day appointed, prayers, ceremonies and incantations followed one after the other; sacred waters were thrown over the man who would collect the combs, and he was finally worked up to a pitch where he could feel nothing. When he arrived at a tree with several nests on it (after dark), one last assurance had to be obtained that the spirits were willing. The man's followers had brought a number of bamboo-sticks, one end of which – previously sharpened and hardened with fire – was hammered into the trunk. If any peg needed more than three blows to fix it there (see under Kalimantan, above), this was taken as a sign that the fates were not propitious, and further attempts on the bees were postponed until another night. If the test was successful, the man was hauled up to the branch from which the nests could be reached, by means of a rope pulled over a higher branch. He climbed along the branch, which supported the nests, lit a big wad of cotton wool or similar material with his flint and steel, and waved it round the nests. As the bees came rushing out in a cloud he dropped the flaming wad, and they followed it to the ground 25-30 m below. He cut down the nests as quickly as possible, and it was said that 200 to 300 would be collected in an evening.

The people feasted on the honey and the brood; the wax was much in demand for candles in temples and for cremation ceremonies. These people ate a variety of insects, but more *A. dorsata* than any other.

Andaman Islands

Negrito (pygmy) peoples in the Nicobar and Andaman Islands (Figure 15.1a,H) used certain plants to pacify *A. dorsata* (Section 15.21). Cipriani (1966) said that an Onge honey collector:

> stripped lengths of green bark from the lianas growing up the tree, and climbed to the nest. He broke this up, and tied the pieces of comb to his back with the strips of bark, then lowered himself down to the ground, swinging like an ape from liana to liana. There, while his friends fell on the honey, he calmly cleaned himself down – with not one sting on him.

Section 18.1 refers to tending of nests by the Onge.

India

Climbing techniques in the Coimbatore Hills, Tamil Nadu, were similar to those elsewhere; in addition, a long bamboo pole was sometimes fixed sloping against the tree, for the honey collector to climb up (Keystone Press, 1994).

Kallapur (1950) and Singh (1957) are among the few authors who described recent honey collection within the systematic framework of a forestry organization, in different parts of India. Operators were provided with bee veils and other appropriate equipment, and taught how to obtain high quality honey from the nests.

15.24 Some other circumstances

In much of this Chapter, ownership or a hereditary right of harvesting *A. dorsata* combs applied to nest sites used year after year. But among some peoples, an individual who found an unowned nest could establish his right to harvest it later in the season by placing his ownership mark on it. In the central highlands and the north of Vietnam, a person who found a young nest made his mark on the trunk of the tree, near the ground, and this was also valid for future years. Someone looking for unowned nests usually worked alone, and if two went out together they worked independently. They tried to find nests not more than 30 m above the ground, and honey from a nest less than 10 m up might be drained out through a hollow bamboo tube.

Much of Bangladesh is now a densely populated area of cultivated farm land where traditional ways of harvesting *A. dorsata* nests have been lost. Also, as a result of changed land use and disturbance, colonies migrated from established nesting areas into cultivated areas – where they were not at risk from ants – and nested in trees only 1-5 m from the ground. A farmer who owned such trees might get a professional honey collector to come – often from quite a distance – to collect the honey, in return for half the harvest. Otherwise, nests are destroyed inexpertly by their owners (Svensson, 1989).

15.3 Cavity nests of *Apis cerana*

Ownership of *Apis cerana* nests was probably widespread in Asia, even in regions where *A. dorsata* nests were present and could yield more honey. Practices are described on two islands where customs have changed less than on the mainland.

On Cat Ba off northern Vietnam, *A. cerana* nested in rocks and was known as the rock bee (or fly bee); *A. dorsata* was the tree bee. One man said in 1989 that if he found a nest in the dearth season, he would mark it for future harvesting by fixing a broken

branch at the flight entrance. He did this even if the nest was deep in the forest where access was difficult, possibly only by boat, but some people would think it unnecessary there. Unless the finder took the bees to use in a hive (Section 10.32), he harvested the honey later, leaving the brood intact and reconstituting the nest; some of the people always used a bamboo knife for cutting out honey combs. If a marked nest was found, it was left untouched. (On the mainland, when a beekeeper took a wild colony, he marked the nest site to show his continued ownership of it; Mulder, 1990.)

The Onge on Little Andaman Island, who got harvests of 'golden honey' from *Apis dorsata* nests in the dry season, also owned *A. cerana* nests in trees and rocks from which they harvested 'darker and poorer honey' during the rainy season. Cipriani (1966) described the procedures.

> Whatever the fruit in season, men, women and children climb happily about like acrobats, hanging in the trees to get at it and the honey that goes with it. ... When one of the Onges finds a nest of bees he puts a mark on the rock or tree as a sign of ownership. None of the others would then dare to take possession of it, for fear of punishment by the group [banishment from the community], but when the time comes to take the honey everyone helps in the hard work of getting at the nest and opening it up. On one trip from Labanar to Togalanghe ... the Onges pointed out over twenty *Nigrocincta* [*A. cerana*] nests to me, all reserved ready for use when the supply of *dorsata* diminished at the onset of the stormy season, when the gales lashing the branches dislodge the nests and hurl them to the ground.

Plants used to pacify the bees (Table 15.2A) included species of *Artemisia* in China (American Bee Journal, 1861), *Shorea* in Thailand (Crane, 1988) and ginger in Assam (India, 1883, Report 4431).

15.4 Nests of the dwarf bee *Apis florea*

In Oman, *A. florea* colonies often nested in caves or fairly open rock niches, and these might be owned for a season. If a person found a nest before the bees had stored honey, he marked it in a way recognized by other people in his locality, typically by a pile of stones or by a stick leant upright inside a cave entrance (Dutton & Simpson, 1977). A colony of *A. florea* suffers less than any other honey bee if its colony is disturbed, because the adult bees often cluster not far away and build a new nest (end of Section 4.2). In Oman, seven disturbed colonies built a new nest between 6 and 65 m from the site of the old one (Whitcombe, 1984a).

Chapter 19 describes the tending of *A. florea* nests, and beekeeping with this bee.

16

Cavity Nests of Honey Bees: Tending and Beekeeping

16.1 The terms used

In this book the term 'tending nests' implies care or protection of them and the bees in them, often with some adaptation of the natural nest sites to suit the beekeeper. Tending of cavity-nesting bees necessarily involved reclosing any enlargement of a hole made when honey combs were harvested, and was likely to include keeping the flight entrance clear, attending to the inner surface of the cavity, and protecting the nest against animals or other marauders. The term 'tree beekeeping' has been in common use for a more substantial form of tending nests in trees, which included fitting doors to cavities, and making new cavities similar to the natural ones. This book uses, in addition, 'rock beekeeping' for equivalent practices with nests in rocks, and 'wall beekeeping' for those where the cavities were incorporated into man-made walls. These activities are thus distinguished from 'hive beekeeping' in which the artificial nest sites were movable containers.

Tree beekeeping (forest beekeeping, in German *Waldbienenzucht*) has been used by some authors more widely to include any method of getting honey from colonies of bees in a woodland area. Much less attention has so far been paid to rock beekeeping and wall beekeeping.

16.2 *Apis mellifera*: tree beekeeping

The tending of *Apis mellifera* nests is known to have advanced to tree beekeeping in the part of northern Europe indicated in Figure 16.2a. Figure 16.2b, from the 1770s, shows two tree beekeepers taking honey combs out of a tree cavity after having removed its upright access door; Section 16.25 explains other details.

This tree beekeeping was probably developed first by the Cheremis in the middle course of the Volga and the lower course of its tributary the Kama (Linnus, 1939). The confluence of the two rivers is near Kazan (55°N, 49°E), east of the area shown in Figure 16.2a. The Cheremis (or Cheremissian) Tatars, a branch of the Finno-Ugrian peoples, lived there at the end of their Neolithic period, around 2000-1000 BC when the climate was mild and supported rich deciduous forests. These probably included limes, willows, oaks, hazel, poplars and pines. Oaks, especially, could develop large cavities which lasted many years. Some people believed that bees preferred oaks, but others said that they disliked both oaks and poplars because of their tannic acid, and tree beekeepers therefore burned straw in the cavities and then coated the surface with beeswax. Openings in the forests provided nectar and pollen from raspberries, brambles and herbaceous plants (Galton, 1971). Tree beekeeping was also done in some coniferous forests which provided enough bee forage, for instance in the Baltic region; cavities in firs and pines were especially mentioned.

There seems to have been a cultural element in tree beekeeping, in that it was done by Finno-Ugrian peoples; as they dispersed across Europe the practice was spread over a distance of more than 3000 km, for instance eastward as far as the Urals, and westward to the Baltic. The practice was also passed on to Slavs, and from western Slavs to Germans. Between 1200 and 1900 – although not necessarily for the whole period – large quantities of honey and wax were produced in this way by Volga-Finnic peoples including Slavs (Russians, Bashkirs, Churashes, Poles), Baltic peoples (Estonians, Livs, Letts, Lithuanians), and Germans.

16.21 The Cheremis people

Cheremis Tatars continued tree beekeeping into the early 1900s, when it was studied in detail by two ethnographers. Albert Hämäläinen published his main report in Finnish in 1909, another which included the neighbouring Mordva people in 1934, and one in German in 1935. (In 1981, in the National Museum of Finland, I was able to examine the Cheremis tree beekeeping equipment he had collected; see Figure 16.2c.) Also, between 1910 and 1928 T.S.

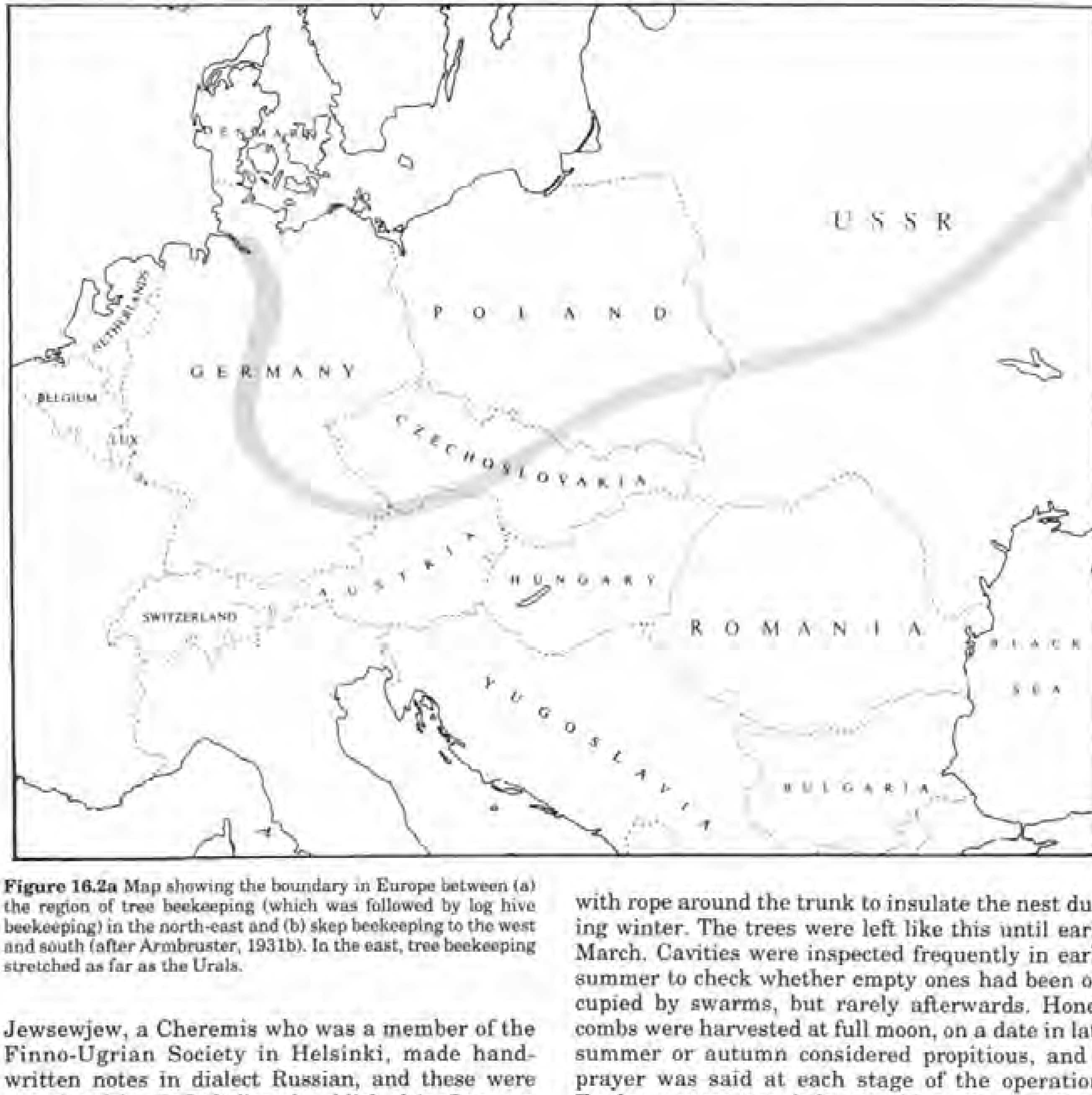


Figure 16.2a Map showing the boundary in Europe between (a) the region of tree beekeeping (which was followed by log hive beekeeping) in the north-east and (b) skep beekeeping to the west and south (after Armbruster, 1931b). In the east, tree beekeeping stretched as far as the Urals.

Jewsewjew, a Cheremis who was a member of the Finno-Ugrian Society in Helsinki, made handwritten notes in dialect Russian, and these were translated by J. Erdődi and published in German, with photographs, in 1974. This Section is largely based on the above material.

Tree beekeepers made an upright rectangular opening to each tree cavity, which they fitted with a removable rectangular 'door'. A small flight entrance was left for the bees. A tree might be climbed unaided, or by using a rope, ladder, or footholds cut in the trunk, or a climber such as that in Figure 16.2c. In October all cracks and holes were covered except for a flight entrance to the cavity, and straw was tied with rope around the trunk to insulate the nest during winter. The trees were left like this until early March. Cavities were inspected frequently in early summer to check whether empty ones had been occupied by swarms, but rarely afterwards. Honey combs were harvested at full moon, on a date in late summer or autumn considered propitious, and a prayer was said at each stage of the operation. Twelve prayers recorded were addressed variously to the Great God, God of Heaven, God of Bees, Mother of Plenty, and so on. Some were a supplication for a good harvest or skill in obtaining it, and others for the future well-being of the bees. They had no obvious Christian connotation, but in Christian times a wax candle was lit in front of a holy picture when the new honey was tasted.

No mention has been found of tree beekeepers putting a swarm into an empty tree cavity, and they may have been unable to do this, but a beekeeper who

Figure 16.2b Tree beekeepers at work, probably in Germany (Krunitz, 1774). Details in Section 16.25.

also kept bees in hives maintained a constant watch on every hot day in early summer when the bees might swarm, and if a swarm issued he sprinkled water on it to encourage it to settle. He put the swarm in a 'bee shirt' – a special sack fitted with ties which could be secured to enclose the bees – so that he could take it to a log hive.

Cheremis people lopped selected trees at the top to allow the trunk to thicken to the required diameter without increasing its height, and the cut top was protected with birch bark or a board held in place with stones. The beekeeper made new cavities in trees using a long-handled axe and chisel, and marked each tree to indicate his ownership (Section 14.42).

In 1913 Jewsewjew reckoned that he was then seeing the end of Cheremis tree beekeeping. The bee woods were disappearing – presumably as a result of land clearance for agriculture – and with them the nest cavities, and the bees. In the old days theft from owned nests in trees was unknown, but in 1928 he found that remaining tree beekeepers were having to take measures against it (Jewsewjew, 1974).

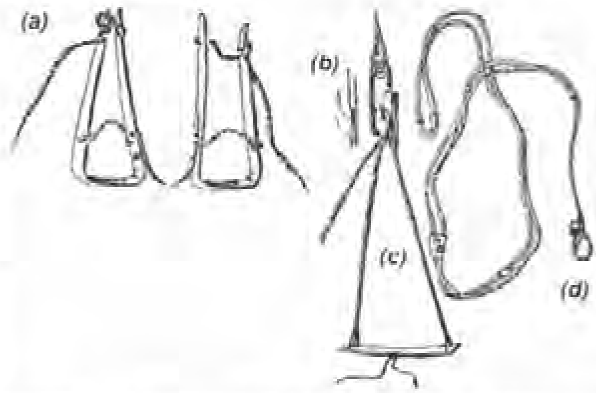


Figure 16.2c Equipment of a Cheremis tree beekeeper, *c.* 1900 (Hamalainen, 1909). (*a*) Device to fit over shoes, the curved spikes being pushed into the tree when climbing; (*b*) Hook from which beekeeper's seat was slung; (*c*) Seat slung from the hook *b*; (*d*) Climbing rope made from inner bark of *Tilia cordata*.

An incipient type of hive beekeeping was practised by the Cheremis people from perhaps the 1200s: they fixed hollowed logs up trees, as additional nest cavities for bees; Figure 26.1a shows an example in Poland.

16.22 Russia

Galton (1971) described early tree beekeeping in Russia. By AD 1000 or earlier, princes and lesser aristocracy (boyars) and monasteries owned many 'bee woods', which were often of great size. A special class of peasant (*bortnik*) looked after bees' nests in the trees, and harvested the honey and wax. A *bortnik* could also own bee trees himself, paying his landlord by services or quit-rent. The Moscow princes originally had bee woods near Moscow and round Kolomna and Mozhaysk, and they acquired many others. Numerous reports about Russia in the 1400s commented on the importance of honey, mead and wax in the economy. These were mostly the products of tree beekeeping, and a 1537 document recorded that 'the most important products of the Moscovian land are wax and honey, despite the fact that the bees put their excellent honey not in artificial peasant hives, but in cavities in trees' (Rozov, 1972). During the 1600s there was some attempt to preserve the forest resources. A 1680 decree by Feodor required the listing of apiaries, identification marks, locations and boundaries, and whether occupied by bees. Moreover it deprived boyars' children of quit-rents on the proceeds of (tree) beekeeping, fishing, and trapping beavers (Rozov, 1972).

Important areas for tree beekeeping in the 1500s were Arkhangel, Vologda, Vyatka, Perm and Kos-

troma, where honey and comb (beeswax) took second place only to grain among produce purchased by monasteries. Jenkinson reported in 1557 that there were bee woods from Ryazan to Nizhny Novgorod: 'On both sides of the said River of Oka is raised the greatest store of waxe and honey in all the land of Russia' (Hakluyt, 1589, quoted by Galton, 1971). Two years later: 'The chief encrease of honie is in Mordva and Cadam near the Cheremissen Tatar; much out of Severskoy, Rezan, Morum, Cazan, Dorogobuze and Vasma' (Fletcher, 1591).

Mediaeval Russian forests contained very large trees; excavations have shown that larches were up to 40-45 cm in the 1100s; oaks and limes would be larger still. Oaks seem to have been widely used by the bees, and also preferred by beekeepers. A large trunk was important because it could contain a large cavity, whether natural or hewn out by a tree beekeeper. Artificial cavities were made between 5 m and 25 m above the ground, sometimes 2 or 3 in one tree. A tree with a straight trunk was used, and lower branches were removed so that the beekeeper could more easily reach the cavity.

Spring was the main flowering period, and a harvest might be taken then as well as at the end of summer. Tree beekeepers followed tracks known as 'bee walks' to visit the nests they looked after, and had to cover quite large areas. Bee trees might be from 0.1 to 1.2 km apart, and a 'bee forest' might contain 100-500 tree cavities, but with only 10 or 20 occupied at any one time. In Sergach, Nizhny Novgorod (Gor'ki), one forest occupying about 1000 ha in 1667 had 10 trees with bees; a second had only 3; a third, of nearly 9000 ha, had 50; and a fourth covering 7250 ha had 12. Rozov (1972) suggested that a tree beekeeper's 'apiary' with 60 cavities might occupy a plot of land extending over 5 to 10 km. Sections 16.23 and 16.25 also refer to this.

From figures quoted in contemporary records, it seems likely that a forest might have between 10 and 100 times as many empty cavities as occupied ones. This suggests that the number of colonies able to live in an area was limited by the amount of bee forage, not by the number of nest sites. It seems puzzling that tree beekeepers nevertheless made additional artificial cavities, but these may have been in trees more convenient to visit and to work at.

According to Klose (1925), tree beekeeping was prohibited in Russia by the 1890s, on the grounds that it had become associated with theft of wood and game from the woods, and – as in West Prussia – with fires that caused damage. Figure 16.2d shows an earlier example in Bashkir in the Urals. A reserve was established there in 1929 (Petrov, 1980). Bees occupied a cavity with a volume of 40 litres or more, and preferred one of less than 60 litres. Measurements made in North American woods were not dissimilar (Section 9.1).

Section 9.5 discusses the biology of colony survival at high latitudes, and the northern limit at which survival is possible. Russian bee forests extended to latitudes near this northern limit; Nizhny Novgorod is at 56°N and Arkhangel at 64°N, both of which Galton (1971) included as important areas of tree beekeeping in the 1500s. The low occupancy of cavities recorded in Russia may have been a result of lack of swarms or their non-survival, resulting from climate changes leading to shorter summers and longer and more severe winters. In some Russian forests,

Figure 16.2d Tree beekeeping in Bashkir, Russia (Krunitz, 1774). Steps were cut in the trees to facilitate access, and each beekeeper (drawn wearing a veil) secures himself with rope before harvesting combs. These are put into tall vessels of coiled-straw work, and lowered to an assistant on the ground.

Figure 16.2e Part of a tree trunk in which bees nested, showing the doorway made by a tree beekeeper (photo: Muzeum im. Jana Dzierzona, Kluczbork). See text.

'barren' cavities (those never occupied) seem to have been more numerous than cavities once occupied.

16.23 Poland

Figure 16.2e shows a tree trunk containing a cavity made by a tree beekeeper; it was found in 1901 in the River Oder near Opeln. A recently obtained radiocarbon date was about AD 900, a thousand years later than the date previously published by Mazak (1975).

Tree beekeeping was carried out in almost the whole of the present area of Poland. Ancient and previously unwritten laws of tree beekeepers, recognized by King Kazimierz I in the Wislica statutes of 1347, gave the tree beekeepers self-rule and jurisdiction (Jankowska, 1989). An area of land containing sixty or more nests of bees was referred to as a *bart*.

The practice of tree beekeeping survived quite widely into the present century, when detailed documentation and photography became possible. It was very important in earlier centuries, and as late as 1750-1800 there were 20,000 occupied tree cavities in one region of Pomerania which lies along the west part of the Baltic coast (Blank-Weissberg, 1937). A 1782 census in Wierzchowiskwa recorded 439 tree cavities, of which 83 (19%) were occupied, a higher proportion than those quoted for Russia. According to laws in force at the time, a tree beekeeper was taxed; he was required to make a certain number of new cavities each year and to obey all guild laws. Anyone who smoked out a colony that was not his own had to replace it, and pay a fine of 2 lb (1 kg) of beeswax (Mazurkiewicz, 1958).

Forests of the area known as the Congress Duchy had some 70,000 occupied cavities in 1827, but by then numbers had begun to decline. In the 1900s Blank-Weissberg found a few cavities still used in the old Polish Kingdom, for instance in the Puszcza Berestowska – between 40 and 60 near Girodna and some in the National Park. There were others in parts of the Polesie region. He deduced from earlier records that this form of beekeeping was most prevalent north of Grodno (now across the Russian border) at 53°40′.

In early times, a tree beekeeper put his ownership mark on a tree he selected for making a cavity, and a few such marks survived in 1937 (Figure 14.4a). The mark was occasionally made on the inside back wall of the cavity where it could not be obliterated. Cavities were excavated mainly in trees which were a metre or more in diameter. Most were pines which took 120 years to reach this size, and Figure 16.2f shows an example. Trees were lopped at the top, as described in Section 16.21. The wooden door was usually a single piece of wood, which might be rebated (Figure 16.2g), or have an extra entrance hole, or be made in two parts. In some areas additional covers were added to give better protection against cold. Straw was sometimes used to insulate colonies in exposed trees, for instance those in a clearing; it could be held in place by sandwiching it between the door and an outer cover. The flight entrance was made in or beside the door, usually facing south-east. In Lausitz, beekeepers used different names for a

Figure 16.2f Massive door to a tree cavity in Bialowieska National Park, Poland (Blank-Weissberg, 1937).

Figure 16.2g Tree beekeeper sitting on his 'climber' ready to remove the rebated door of a cavity in a large tree (Szacki, 1980).

tree in which they had made a cavity and one in which a woodpecker had done so (Klose, 1925). Methods for climbing trees were similar to those already described; see Figures 16.2b, 16.2c and 16.2d.

In earlier centuries bears were the tree beekeeper's chief enemy, and various forms of protection were devised against them, as in Figure 5.2b. A heavy stone or block of wood was suspended near a nest on a hemp rope or leather strap, so that a bear trying to reach the nest was knocked on the head. Sharp iron spikes or hooks were fixed in the ground, or in the tree trunk round the opening, or on the underside of a board suspended below the cavity. Many of the contrivances made it more difficult for the beekeeper to work at the nest.

16.24 Baltic lands

Tree beekeeping spread to the east Baltic coast north of Poland, and was described in Lithuania and Latvia by Klose (1925) and in Estonia by Linnus (1939).

Lithuania

Tree beekeeping in Litau – which in some periods included parts of present Poland and Russia – was in many ways similar to that in Poland. For instance Klose described the part played by woodpeckers, which usually drilled out their nest cavities from the south side of a tree. Many woodpecker holes were enlarged by tree beekeepers, who usually placed their upright access door on the east side, and sometimes fixed a piece of bark or a stick near the flight entrance for the bees to alight on.

In 1730, bees were kept in Strahlenberg 'in the highest and straightest *Tanne* [fir or pine] in the woods'. In Zubrowo, when a tree containing a nest died, the section with the nest was cut off (1.5-2 m long) and placed upright near the house as a log hive; 6 to 12 such hives were often kept in a garden.

Latvia

Records of tree beekeeping survive from the 1200s and 1300s. In 1253 the (German) Teutonic Order secured hereditary rights over bee trees in some areas. In the 1300s, especially in Riga, landowners started to limit the rights of tree beekeepers, for instance prohibiting the making of new cavities. In

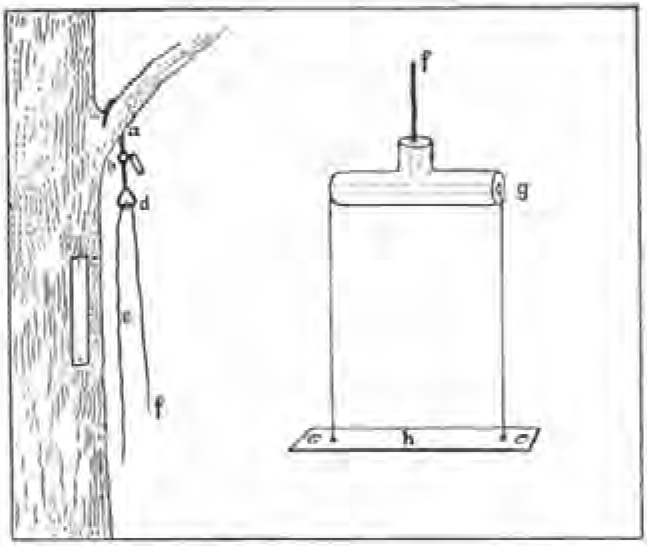


Figure 16.2h Tree-climber used in Kurland, Latvia, in 1896 (Klose, 1925). *a* hook; *b*, *d* ring; *e*, *f* rope; *g* stick/handle; *h* seat

1544 a theft of honey in Riga was punished by the relatively large fine of 9 Marks (Linnus, 1939).

In Kurland, further limitations were imposed in 1570, but tree beekeeping continued in some parts until the 1800s when peasants in the north were allowed by landowners to make cavities for bees in a variety of tree species; in return they had to pay annually 20 pounds of honey for every 10 bee trees. For example the Schlehk estate received 1800 pounds of honey from 900 bee trees. In the swarming season tree beekeepers hung light bait hives made of bark in the trees, and swarms that nested in them were left until the autumn and then transferred to log hives.

Bee trees were discussed at an Archaeological Conference at Riga in 1896 (Klose, 1925), and Figure 16.2h shows a tree-climber described there. A man sits on the seat *h* and hoists himself up to the nest shown, by pulling on the rope *e* – which, it was emphasized, involved much hard work. (In Figure 16.2b a German tree beekeeper is sitting on a similar climber.) For a smoker, a handle was made at the lower end of an ash branch nearly a metre long; the upper end was split along the grain to make it burn better, and was lit before the tree beekeeper climbed up to the nest.

Estonia

Tree beekeeping in Estonia had many similarities to that in Latvia and Lithuania. In 1940 the Estonian Ethnographical Museum at Tartu published Linnus's 12-year study of the subject. He found that tree cavities were made about 1 m high and 30 cm in diameter, near the south side of the tree and between 1 and 6 metres above ground. Natural cavities were sometimes enlarged by burning. To prevent wind damage to a bee tree, the top was commonly cut off. Until the mid-1800s when the last bear in Estonia was killed, anti-bear devices (mentioned above) were needed. Unusually, two cavities made in the 1900s had a second opening below the flight entrance, through which smoke could be blown into the cavity to drive the bees out. These cavities were used as 'bait hives' to attract swarms for use in log hives. By the 1930s, tree beekeeping was done in only eleven trees, all pines, whose cavities were also used as bait hives for swarms.

Regions farther north

The above descriptions show that the custom of tending bees' nests in hollow trees in the Volga-Kama region (Section 16.21) remained with the proto-Finnic peoples who settled in the Baltic area. Finnish ethnological studies (Varis, 1993) show that peoples who moved on north to what is now Finland could not continue the practice, because the winters were too long and cold for bees to survive in tree cavities. Nevertheless memories of bees, honey and mead remained submerged in their inherited traditions, vocabulary and folklore; see Section 48.33. In the mid-1500s directions were given for making mead from honey, with the comment: 'The upper class apparently had means enough to buy honey from the Baltic area.'

16.25 Germany

Tree beekeeping spread as far as present eastern Germany. Armbruster (1938b) established that in 748 the Bavarian duke Odilo made a gift to the Mondsee monastery on the River Isar, east of present Salzburg, which included woods and pasture land; men who worked there included six *cidlarios*, translated by Armbruster as *Zeidler*, the German word for tree beekeepers. Both words probably meant cutter (of combs out of tree cavities). In 993 the word *Zeidelweide* was used, probably meaning bee pasture; in 1779 in Muskau, Oberlaustiz, it represented an area containing 60 bee trees (Weiske, 1971) – as in Russia and Poland. The Muskau woods then contained 7000 cavities for bees hewn out by *Zeidler*.

Throughout the Middle Ages, church establishments owned much land in which tree beekeeping was important. Kloster Dobrilugk,

founded in 1165, had land which included *Zeidler* law courts by 1226, and these had their own jurisdiction by 1315. Schwärzel (1954) cited examples of honey tithes paid to Meissen Cathedral in 970, and payments of honey or wax to other church establishments from the 900s to the 1200s, but these may not always have been obtained from tree beekeeping. A surviving *Zeidler* court book for the Lorenz Forest recorded cases heard during the period 1451 to 1514 (Weiske, 1971).

Important centres for tree beekeeping included Pomerania on the Baltic coast, Brandenburg (with Kurmark) near Berlin, Finsterwald north of Leipzig; to the east there was Görlitz, also Oberlausitz and Silesia which in certain periods were in Poland, not Germany; and farther south Nürnberg in Bavaria (Bessler, 1886; Schwärzel, 1954).

Figure 16.2b shows honey being harvested in the 1770s. On the right, a beekeeper standing on a ladder has removed the door and is using a tool to cut out honey combs in the cavity. On the left a beekeeper sits in a climber like that in Figures 16.2c and 16.2g, smoking the bees with a pipe and using a tool to cut out combs which are visible through the open doorway. At the left is a bag for catching a swarm; its supporting framework has a loop to fit on to a long pole, and the draw-string at the bottom allows the bees to be dropped out into a hive. At the bottom of the Figure, a tub, basket and bag are ready to receive the honey combs which will presumably be dropped down individually to the assistant with the upstretched arms.

Figure 16.2i Woodcut of a Nürnberg *Zeidler* with crossbow and two arrows, standing on a straw skep which symbolized the privileges granted to him in 1350 (C. Scheurl von Defersdorf, *De iure mellicidii*, Altdorf, 1690).

The term *Zeidler* was sometimes used for a honey hunter, bee hunter or hive beekeeper, as well as for a tree beekeeper, and an individual might work in more ways than one. It seems likely that tree beekeepers were also hive beekeepers from the Middle Ages or earlier (Bessler, 1886). Their right to take swarms was stated in the 1350 letter (below), and a swarm would have had no value except to put in a hive. As in Figure 16.2i, a *Zeidler* was often represented standing on a straw skep – which symbolized his privileges and rights to swarms and other benefits.

In 1350 the Holy Roman Emperor Charles IV issued the so-called *Zeidler Freiheitsbrief* 'for all our dear and trusted *Zeidler* of the Nürnberg Reichswald [State Forest]'. The letter refers to 'all their rights which they have had for a long time'. Like forest officers, they had immediate executive powers when crimes were committed in the forest. They were controlled by a *Zeidelmeister*, and in cases of misbehaviour were tried in the court at Feucht. Because of their hereditary rights, the *Zeidler* of the Reichswald were obliged to provide six crossbow-men for military service – but within a limited distance of the forest so that they could also attend to their bees (Bischoff, 1973). The *Zeidler* crossbow and arrows are shown in Figure 16.2i.

Further publications on *Zeidler* include those by Schirach (1774), Glock (1891), Wagner (1895), Schwärzel (1981) and Thäter (1993). Some tree beekeeping was done as far west as Rheinland, where a study by Steinhausen (1950/51) referred to occasional use of nests in trees around the 1920s.

16.26 Other regions

During the Middle Ages the forests stretched much further south than nowadays. In the 900s there were vast woods around Kiev in Ukraine, where tree beekeeping was done from the 700s and was an important industry by the 800s; tribute to the Grand Princes was paid in honey and wax. Ownership marks used in feudal Ukraine are discussed in Section 14.42. Apiaries of log hives were not established until the 1600s (Shrishenets, 1986).

There was tree beekeeping in eastern Slovakia (Balassa, 1957), in forests now part of Hungary and Romania and other parts of the Carpathians (Gunda, 1968), and in the Carpathian basin (Balassa, 1975). In England, tree cavities were occasionally fitted with doors; Betts (1927) referred to some 'in the eastern counties, here and there', and Crane (1983a) published 1978 photographs of two in the New Forest.

In many areas honey hunting persisted without any development into tree beekeeping, although there might be occasional tree ownership marks and other signs of it (Gunda, 1968). Whereas tree beekeeping flourished greatly east of the Baltic, no records of it have been found in Scandinavian countries to the west; probably colonies in trees could not survive the winters.

16.3 *Apis cerana*: tending nests and tree beekeeping

Records from Asia are scarce, and the following relate to the 1900s, but the practices described may be much older. People in one part of the middle Mekong river basin in Laos (Figure 15.1*a*, north of N) sought out nests of *A. cerana* in tree and rock cavities, and tended them to the extent of repairing and protecting the access holes they made (Seguin, 1975). These Lao people were rather feared by others, almost as if they were sorcerers, and they were said never to be stung. Lao people held various beliefs relating to bees, and before setting out for the nests they performed a ceremony to propitiate the guardian spirits of the forest and ensure that the expedition would be successful. Methods of gaining access to nests in rocks or trees were mostly similar to those described elsewhere; for instance pegs were driven into a tree trunk for use when climbing it. Like other peoples in Chapter 15, the Lao gave each peg only three blows, because a fourth would send the point of the peg into the heartwood of the tree and so damage it. They ate bee pupae and larvae as well as honey, and obtained beeswax by boiling the squeezed combs in water; they also collected bear droppings – especially those of the Malayan sun bear *Helarctos malayanus* – to extract the beeswax from them.

The main honey-producing area of Laos was farther south in Sekong province, between latitudes 15°30' and 16°N (Figure 15.1a, N), where the people practised slash-and-burn agriculture. The province is about 100 x 100 km², bounded on the west by the Sekong River and on the east by Vietnam south-west of Hué. It is of special interest because a form of tree beekeeping was carried out there, which Khatri (1990a, 1990b) recorded in 37 locations in Dakchung district, 4 in Kalum and 4 in Lama.

The bees nested in both natural and man-made tree cavities, and every family tended them, from 10 to 160 per family, on average 40. In general no one owned trees, but a family or person who made a cavity for bees then owned it, and this ownership was hereditary – except that as fresh land was cleared for cultivation, trees containing cavities were destroyed and cavities were made in others.

The following account is based on Khatri's 1990 descriptions. Beekeepers chose trees within easy reach of their village, although not too close, or the bees would not settle in them. If the trees were too far away to allow frequent inspection, nests were likely to be destroyed by the Malayan sun bear, or occasionally the Asiatic black bear (*Selenarctos thibetanus*).

Living trees were used, including species of *Adina*, *Dalbergia*, *Dipterocarpus*, *Garcinia* and *Sandoricum*. In September-October cavities were excavated (one per tree) ready for the arrival of swarms in December-January. An axe with a long handle was used to make a cavity, usually about 50 x 25 cm; the floor was only about 50 cm above the ground, because the people lacked equipment to make cavities higher up which would have been safer for the bees. The work took 3-4 hours for soft wood or a full day for hard wood. A rectangular opening about 50 cm high and 15-20 cm wide was made on the sunny side of the tree. It was important that not much sap oozed out when a cavity was excavated, and a new cavity was left open to dry out until no more sap appeared. Old cavities were also cleared out and prepared.

When swarms started to arrive the beekeeper inspected his cavities every few days to see which were occupied (perhaps half those made, in all), and he then closed the opening with a wooden door – usually a thick piece of wood, because of the inadequacy of hand tools – and sealed it with mud, leaving a small flight hole. In Figure 16.3a the door has been removed to show the interior. Subsequently he might visit the cavities every 10 days or so. The only form of management was to clear the flight hole if termites (*Globitermes sulphureus*) tunnelling in the tree had blocked it, because the bees would otherwise starve.

The harvest was generally taken in May-June when the rainy season started. The door was unsealed and combs removed with a pointed stick. The bees were not smoked, but brushed off the combs with a leafy twig; they clustered on a branch nearby, and shortly flew off (absconded) to the higher moun-

Figure 16.3a Purpose-made tree cavity for an *Apis cerana* colony, Sekong province, Laos, 1990 (photo: B. Khatri). *above* Cavity with door removed to show new comb; *right* Beekeeper replacing door.

tains where they lived for the next 6 months. Next year the beekeepers made new cavities to replace those destroyed by forest clearance or now too close to cultivated land.

Chinh (1994), who studied this beekeeping in Dakchung, found that a family owned four or five nests in 1970, but now many more, as a result of a development programme, and some families owned up to 100. The preferred cavity volume was 15-20 litres, from which about 0.5 litres of honey was harvested. Wax was rather little regarded, and was exchanged for other goods or sold in the market for candle making.

This tree beekeeping has not led to the use of hives as in northern Europe; incentives that could have stimulated the development of hive beekeeping were absent in Sekong where the people lived a semi-nomadic life in the tropical forest, shifting their villages to more fertile land every few years.

In Ha Tuyen province in north Vietnam, the Dao people used tree cavities in a similar way (Mulder, 1990).

16.4 Tending nests in rocks, and rock beekeeping

In warm dry parts of the world, honey bees often nest in rock cavities or fissures (Section 7.2). Where the rock was very soft, cavities could be enlarged or excavated by scraping with a suitable hand tool. One soft rock is loess, a mud-like composition of unweathered mineral particles originating in arid regions and transported by wind. Accumulations cover large areas in south-east Asia, North and South America, and eastern Europe. Another is tuff which

consists of compacted volcanic fragments, and is restricted to areas affected by past volcanic activity.

In some inhabited regions, people adapted accessible cavities in loess or tuff to make them acceptable to bees as nest sites. Later, they excavated new recesses in a place convenient to themselves and safe for the bees, and fitted doors to them. Where soft rock occurred, a fairly large number could usually be made close together, whereas in tree beekeeping the cavities were often far apart.

Bees were kept in rock cavities in several parts of the Balkans. Loess cliffs near Lake Katlanovo, south-east of Skopje in Serbia, contain many recesses that were used by local beekeepers as bait hives to attract swarms (*Apis mellifera*) for use in their own empty hives. The recesses were given a smooth lining of cow dung, and closed by a wooden board containing a flight entrance (Nachtsheim, 1921). In Macedonia, use was made of existing cavities in loess cliffs. Beeswax was spread over the interior to attract bees, and W. Banzhaf (quoted by Armbruster, 1932a) reported that the owner put his initials on the stone door, sometimes embellishing them with melted beeswax. Recesses were also made for bees in soft rock in Albania (Rupp, 1959). Domaćinović's (1989) map of Yugoslavia (his 1.514) shows two places in Croatia where villagers made cavities in soft stone cliffs to attract swarms, and closed them with a stone slab.

Recesses for bees in the Bükk mountains near Eger in northern Hungary seem to have been originated by the Agrians, a small group of people of Balkan origin who lived in the area from the 800s to the 1300s. These roughly rectangular cavities can still be seen on vertical or steep slopes of volcanic tuff; they are usually about 25 cm deep, 60 cm high and 30 cm wide. Királyszéke, a cone-shaped hill near Szomolya, has 90 whose edges were rebated so that a board could be fitted as a door. Armbruster (1970) published further descriptions of these recesses, and many photographs. Toth (1981) reported that in 1973 Andor Saád found relics of similar recesses 'in the Balkan mountains', some with a wooden framework for a door. Armbruster (1934) reported many recesses in a wall of tuff near Brindisi in southern Italy (Crane, 1983a, Fig. 217).

Part of Cappadocia in Central Anatolia (Turkey) is formed of volcanic tuff from an eruption of Mount Argeus long ago, and for many centuries cavities for houses and churches were excavated in this rock formation. Bodenheimer (1942) was reliably informed that 'in ancient times the people used to make holes in the rocks, or profit from the existing ones, and settled bees in them; entrances were 3 or 4 m above ground, to guard them against theft'. Near Göreme in Cappadocia, I found 14 such recesses in use in 1985, excavated from a 'cave' made behind a dressed stone face (Figure 16.4a).

Figure 16.4a Rock beekeeping in Cappadocia, Central Anatolia, 1985 (photo: E. Crane). The beekeeper entered his cave through a door (not visible) which, for protection, was about 2 m above ground level.

Colonies were tended in rock cavities in at least two parts of north Vietnam (Mulder, 1991): by Dao people in Ha Tuyen province (end of Section 16.3), and in Quang Ninh province. When people there harvested combs, they cut each off flush with the roof of the cavity, then cut the upper honey part away from the lower brood part; the boundary between the two areas is horizontal in *Apis cerana* combs. They replaced each piece of brood comb in the cavity, fixing it in position against the roof with the aid of a forked bamboo stick (see Crane *et al.*, 1993b, Fig. 9). Figure 20.5d shows a similar use of a forked stick in Egypt.

Tending nests in buildings

In Guinea-Bissau on the west coast of Africa, bees (*Apis mellifera adansonii*) were kept in a wide variety of hives. But in the coastal area of Calequisse, and also on one or more of the off-shore islands, swarms customarily nested in the dark interior of a storeroom or bedroom of a dwelling house (Svensson, 1984). The people did not disturb the colony, and honey combs were harvested at regular intervals.

In 1973 I was taken to a small mud house in Nekemte, Walaga province, in the Ethiopian highlands, where a nest (probably *A. m. monticola*) occupied a corner of a bedroom. As in Guinea-Bissau, the bees caused no trouble, and they provided a honey harvest each year.

Figure 16.5a Colony in a cavity in the boundary wall of a garden in Erfoud oasis, Morocco, 1964 (photo: E. Crane). The small flight holes are on the right.

16.5 Wall beekeeping

In certain areas, cavities for colonies of bees were incorporated in walls – mostly of stone – when these were built. The cavity was usually covered on one side with a wooden door or stone slab, and a flight entrance made on the other. Or the door might be on the same side as the flight entrance. This practice is referred to here as wall beekeeping, and in Asia the cavities were called wall hives. Areas in which I know of bees kept in this way are roughly between latitudes 30° and 50°N; they are discussed in order from west to east: in Spain, France, Morocco, Algeria, Italy, Albania, Greece, Cyprus, Turkey, Iran, upper Indus basin, sub-Himalayan India, Nepal and also Bhutan.

The practice dates back at least to Roman times, since Columella referred to it in the preface to his Book IX on agriculture: 'Within our own memory accommodation for bees was provided either in holes cut in the actual walls of the farm building, or in sheltered porticos and orchards.' The next record found was written by Ibn-el-Awam who lived at Seville in Spain in the 1100s. He added to a description of various hives: 'Others make round or square openings in walls, ... slightly inclined or converging towards the base' (Clement-Mullet, 1864). In Galicia in northern Spain, Chevet (1988b) found cavities in house walls still in use in Padron and neighbouring villages. There were similar cavities in several buildings in the Saintonge region, north of the Gironde estuary in France (Chevet, 1988a).

Colonies can survive the temperature conditions in some Saharan oases only if they are housed inside a thick house or garden wall, and in 1964 I saw them in El-Keláa-des-Mgouna and Erfoud in Morocco. The opening was covered with small strips of wood and the whole plastered over, as in Figure 16.5a. Armbruster (1957) published (probably upside-down) P. Baldensperger's photograph of an apiary at Ain-Safra 'at the entrance to the Atlas-Sahara' in Algeria. Near the top of a stone wall were three cavities, their openings made rectangular with mortar and each closed with a board; bees flew out through cracks left open.

In south-east Italy, Armbruster (1926) described wall cavities with a wooden cover near Cerignola, and (1928) showed 14 in a photograph. He mentioned others in Italy.

In some islands of the Cyclades, rectangular cavities for bees were made near the ground in stone walls. In Tinos, where their use was referred to as the 'ancient system', the cavities were about 30 cm wide and high and 125 cm deep (long); the side slabs were packed in place with small stones for insulation, and ventilation was sometimes provided (Showler & Showler, 1985). In Paros, surviving cavities were 30 cm wide and high, and about 70 cm deep (Bikos, 1991). In Andros, where other hives were placed in wall recesses (Figure 32.2f), Nicolaïdis (1955) described a type of self-standing structure still in use, built to accommodate a number of colonies of bees. It had cavities in two or three tiers made from stone blocks; each was closed with a wooden board which was removed to take the honey. Similar structures in the barren Mani district in the south of the Peloponnese were described by Nicolaidis (1955) and Köger (1986). There are also wall cavities in Florina (Macedonia) and Karditsa (Thessaly) in Greece (see Nikiti, 1996).

In Cyprus, the earliest mention of beekeeping in *Excerpta Cypria* is a 1483 reference to one of these

cavities. A monk Felix Faber entered an empty cell in a Dominican convent, and noticed a wooden door that closed off a cavity in the outside wall. He opened it, and 'immediately there burst upon me an infinite swarm of angry bees ... There was a little hole in the wall by which they entered from the garden into the cupboard.' Such cavities were also mentioned by Possot in 1532: 'the bees are inside the houses of the village, and on the outside of the walls they have little holes to go in and out, and the wax and honey are thus inside the houses. This is the fashion throughout the Kingdom of Cyprus.'

Round Bursa near the north-west coast of Turkey, I saw walls with many rectangular cavities in 1985, but few were then in use. The village of Ürünlü had more than 30, in a single or double row a metre or more from the ground, with the wooden door on the outside (Figure 16.5b). One recess in a house wall had the access door inside the kitchen. Pechhacker and Hüttinger (1995) mentioned recesses in northern Greece and in Iran.

All the above cavities were for *Apis mellifera*. In Asia similar wall hives for *A. cerana* were very common in the sub-Himalayas – from the upper Indus basin, through Himachal Pradesh and Uttar Pradesh in India, and the Terai and lower valleys of Nepal (see Figure 16.5c), to beyond Kathmandu, and also Bhutan. Near its source, the Indus runs through Ladakh, which is high above Srinagar and the Jhelum valley in Kashmir; Leh is at about 3500 m. In 1975 bees were kept in wall cavities separated by upright beams, and the wooden door of each contained the flight entrance. In 1944 Mullik found bees 'flourishing well' in wall cavities in almost every village in Hazara District in Pakistan. In Garhwahl District, UP, India, 'most of the families' kept bees in wall hives; in some places 'wooden vessels made of tree trunks' were also used (Gaur, 1983/84). In areas with both wall cavities and hives, I was often told that bees did better in the wall cavities. These varied somewhat in size; over 150 near Jeolikote in Nainital District, UP, were on average 38 cm long and 25 cm deep (Muttoo, 1954); Verma (1992) reported a width of 30 cm and height of 45 cm; and most I measured in Nepal were about 45 x 45 cm, and 30 cm deep.

Round Pokhara in Nepal, a wall hive was made – usually in the south gable end – when a house was built (Figure 16.5c), or it might be excavated later; there were sometimes several in one house. They might remain unoccupied for several years, but some beekeepers collected swarms to hive in them. Inside the cavity, wooden boards might be plastered with mud on the roof from which the bees would build their combs. The wooden door of the cavity was accessible from inside a room or loft. When harvesting, three combs were said to be left to encourage the colony to remain, but colonies were not fed: the beekeepers were too poor to buy sugar.

Within the past few decades a hundred cavities were built in the brick boundary wall of the Royal Forest at Gokarna near Kathmandu; they were used as bait hives for swarms which came in January/March, and were not occupied permanently.

Figure 16.5b Six of the many cavities in the courtyard of a house in Ürünlü near Bursa, W. Turkey, 1985 (photo: E. Crane). Swarms were housed directly into these recesses, and colonies still occupied some others in the village.

Figure 16.5c House showing the flight entrance to a wall hive for *Apis cerana*, shaded by a canopy on the south gable end (the usual site) at Reliachur near Pokhara, Nepal, 1984 (photo: E. Crane).

Circumstances in which wall hives were used

The above areas where bees were kept in wall cavities lie between about 30° to 40° (or 50°) N, along an 8000-km belt stretching from Morocco and Spain to the eastern part of Nepal. The areas seem to have the following characteristics in common. Rainfall was not very high, and land boundaries were protected by walls rather than by hedges or bushes. Average winter temperatures were not below 5°-10° at sea level, and colonies could survive in stone cavities (Section 7.2). Many of the areas were rather distant from centres of development of hive beekeeping, but most were in or near regions where hives were used horizontally and harvested from one end, not upright (Section 20.12). The practice of using wall cavities seems to have been a more primitive, but not necessarily earlier, alternative to the use of hives, and may well have developed independently in different areas, at different times. In hot regions, suitably placed wall cavities had an advantage over hives in that the bees were more effectively insulated against both high day temperatures and large diurnal temperature changes.

17

Cavity Nests of Other Honey-Storing Insects: Ownership and Tending

17.1 A minor worldwide role

This Chapter traces some rather modest developments, in widely separated regions, concerning the owning and tending of nests of stingless bees, bumble bees, honey-storing wasps and honey ants. Chapters 11 and 13 describe the hunting of these nests, and Section 16.1 explains 'tending'.

Normally any tending of nests was done by the owner or another individual who had the right to take future harvests from them. But a few hunter-gatherer peoples tended nests of stingless bees for the common good of the group rather than for such individual benefit.

Hive beekeeping with bumble bees is also referred to here (17.3), but the much more important hive beekeeping with stingless bees is treated separately in Chapter 30.

17.2 Stingless bees

17.21 Africa

Table 8.1A shows that nests of stingless bees were hunted in many countries of Africa, but that nest ownership was restricted to nests of honey bees – which generally yielded more honey.

17.22 The Americas

In tropical America there were no native honey bees, and nests of stingless bees were hunted (Section 11.4), also owned, and possibly tended by some peoples. When honey was taken from nests, brood and some honey were left in place so that the colony had a chance to survive. We have no idea when or where this practice started, and most records below are recent.

The Kayapó people in the Brazilian Amazon basin were very clever at identifying different stingless bees and in finding their nests. Some of them, including Gé-speaking people, always left honey and brood behind 'for Bep-kororoti, a powerful shaman who was taken into the sky in a flash of lightning' (Posey, 1983a). In Rio Grande do Norte in northern Brazil, around the 1870s one landowner hollowed out his large papaya trees and established and tended nests of *Melipona fasciata scutellaris*. Brunet in Bahia tended nine species of stingless bees in tree cavities; they made a hole near the part of the nest where honey was stored, and kept it covered except at harvest time (Schwarz, 1948).

In the upper Amazon basin of Brazil near the Peru border, a number of mixed native-European people settled in Acre during the First World War, and obtained a living by tapping rubber from wild trees and collecting Brazil nuts; each had a small plot for growing his own crops. Dain (1989) studied the relations of these people with stingless bees. They got honey from more than twenty species in nests they kept a lookout for, when walking their trail from one rubber tree to the next. They opened the nest once every two years to harvest honey, and afterwards bound up the tree to reconstitute the cavity. If the bees accepted this within five days, the colony would make the nest permanently secure, grow larger, and store more honey. Each man kept the location of his nests secret, so that no one else would take honey from them. Beeswax was important to these people in many ways: for instance as an adhesive, for patching, for sealing seeds in containers to preserve them, and for sealing re-used shotgun shells.

In Paraguay farther south the Guayaki paid periodical visits to nests they located, opened them with a stone axe and often closed them again after taking the honey (Vellard, 1939). Native people in the Paraguay River basin respected an ownership mark which the finder placed at a stingless bees' nest not yet ready for harvesting. At harvesting time the owner returned with his wife and chopped the tree down to collect the honey (Schwarz, 1948, from a 1926 report).

The Mataco of Gran Chaco did not own stingless bees' nests, but they had a strong taboo against destroying them, and after harvesting they remade a

nest and its cavity in the tree or the earth where they found it (Alvarsson, 1988). This service to the bees was done in accordance with the Mataco religion, and the people as a whole benefited.

17.23 Australia

In Australia, as in the Americas, honey and wax from stingless bees were widely used, and there were no native honey bees. Individual ownership was unknown in the arid Nullarbor Plain of South Australia where Daisy Bates (1938) lived for many years among the Aborigines. But an Aborigine in northern Queensland said that stingless bees' nests were jealously guarded there, and ownership marks were put on trees containing them; his people had a rich hunting area accessible only by river, with a secret landing place kept hidden from other peoples (Dollin, 1987). In some regions, for instance the Herbert River in Queensland, only members of certain families climbed trees to find honey (Gunda, 1968), so perhaps they had a hereditary right to do so.

Dollin and Dollin (1986) found trees in which nests were tended in two areas. One (Dollin, 1990) was on the west coast of Cape York in Queensland in the Aboriginal community of Kowanyama. A 'long-nose' stone axe was used to cut an access hole, about 10 cm across, to a cavity in hardwood trees such as ironwood (*Erythrophloem chlorostachys*), or wider in softwood trees. A long brush of plant material was inserted through the hole to extract the honey, and the hole was then sealed with mud. Sometimes slashes were cut into the tree as toe-holes for ease of climbing. A tree was owned by an individual member of the community and might be marked by tying a long strand of grass around it; similarly marked trees were found in other areas in central Cape York, and the upper part of one tree had contained two tended nests.

The other area was one that figured prominently in ceremonial and ancestral associations, including the creation of honey from blood by the ancestral brothers Antuwtjilb and Narlt, and of various kinds of stingless bees. In Northern Territory about 100 km east of the border with Western Australia, many stunted paper-bark trees were found near the conjunction of two rivers (Dollin & Dollin, 1986), six with live nests of bees (*Austroplebeia*), and many others with exposed cavities which an old Aborigine said had contained nests several generations back. As at Cape York, nests had been opened by chipping away the trunk with a stone axe until the honey was reached, and afterwards sealed up again.

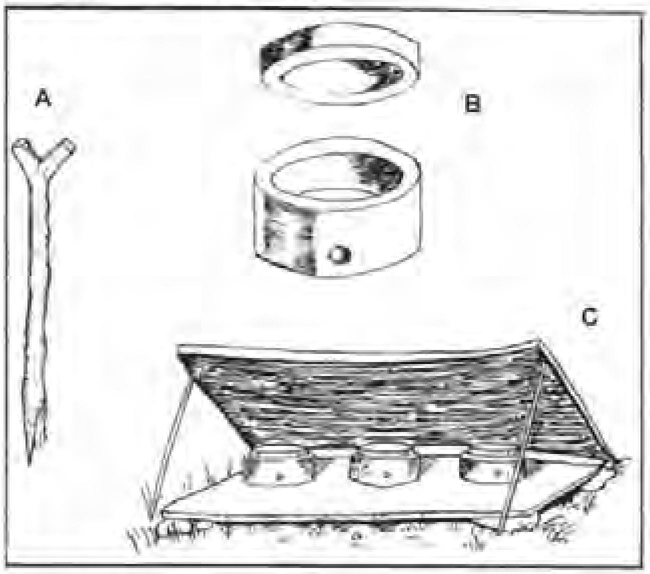


Figure 17.3a Hungarian hives for bumble bees, and digging stick for obtaining nests (Gunda, 1968). **A** Primitive digging stick from Göcsej region, Hungary; **B** Clay hive from Harghita Mountains, Transylvania, Romania; **C** Three of the clay hives on a covered shelf.

17.3 Bumble bees, including traditional hive beekeeping

Nests last only through each summer in the north temperate zone where most bumble bees live, so any ownership would be short-lived. They were nevertheless tended *in situ* in at least one place in Lower Őrség in the Carpathian mountains, south-west Hungary (Gunda, 1968). A nest discovered during grass cutting, harvesting or tree felling was opened up with a digging stick (Figure 17.3a,A), and care was taken that no earth fell on to the cells after the honey was removed. Brood cells were put back and small sticks laid over them to support a protective layer of moss. Finally all was covered with earth, and a flight entrance created by driving a stick into the earth and removing it. Colonies so treated survived, and stored more honey.

Hungarians in the Harghita mountains, now a part of Transylvania in Romania, practised a form of beekeeping with bumble bees (Gunda, 1968). Nests found when grass was cut were put into lidded clay pots provided with a flight entrance (Figure 17.3a,B). Pots were left *in situ* until flying bees had returned in the evening, and then taken to the house in the village and placed three or four together on a covered shelf (C). From time to time honey was taken from them.

In countries of Europe and North America, many

householders unwittingly provided hives for bumble bees by erecting nest boxes for small birds. In Britain in the 1970s, of 27 such boxes where both birds and bees attempted to nest, the bees did so successfully in 5 after the birds had flown, and in 22 after they had driven the birds out (Crane, 1974).

Sladen's classic work on the bumble bee (1912) discussed 'how to domesticate it', and recently certain species of bumble bees were reared in hives to pollinate crops (Section 45.61). Additionally, in many parts of the world some crop growers ensured a large population of bumble bees by providing a habitat suitable for nest sites, and protecting the bees and their nests against marauders. This was being done, for instance, in 1965 in the backlands of Nova Scotia, Canada, on borders of land where low-bush blueberries grew wild.

17.4 Honey-storing wasps

Species of *Brachygastra* (= *Nectarina*) are the best known of the honey-storing wasps, and some are listed in Table 13.3A. *B. lecheguana* occurs as far north as Texas, USA, and colonies may continue for many years. Some species were 'kept' by native peoples of Mexico, and nests were also tended. The people found the nests when small, and might move them to a more convenient site or leave them where they were; when a nest became mature, they harvested honey and destroyed the nest. 'Wasp farmers' collected young nests and transplanted them to places where these could be protected; the people 'periodically oust the inhabitants with smoke, destroy the nest to obtain the honey, and allow the wasps to return and rebuild the colony' – which happens if the base is left attached to the branch (Evans & Eberhard, 1970). In Panama, Caron (1985) mentioned a nest being moved near a house.

In northern Peru the two most important species were *B. lecheguana* and *Polistes flavifrons barbatula* (Garcia, 1978). Both were reared recently in a form of 'vespiculture' for their honey, and also on a commercial scale for larvae to be fed to captive song birds and young turkeys. People also ate the larvae. *B. lecheguana* honey is toxic at some seasons, probably when the wasps forage on nectar from a toxic plant such as *Datura*.

17.5 Honey ants

No evidence was found that nests of honey ants were owned or tended, although those of some other ant species were. Bodenheimer (1951) quoted references by H. Sloane in 1725 and A. Herrera in 1885/86 to native peoples in New Granada (modern Colombia) who made ants 'their main food' and kept and reared the ants in their yards, and sold them in the markets.

Part IV

HONEY BEES THAT NEST IN THE OPEN: TENDING AND BEEKEEPING

Chapters 18-19

18

The Giant Honey Bee *Apis dorsata*: Tending and Beekeeping

Chapters 18 and 19 describe traditional forms of tending, and beekeeping with, two species of tropical honey bees in Asia that build a single-comb nest in the open. *Apis dorsata* and *A. florea* cannot be kept in closed hives, but artificial nest sites were established in appropriate outdoor positions. More recently, attempts were made to devise rational hives for them that were only partly enclosed.

18.1 Tending nests and nest sites of *Apis dorsata*

In many parts of tropical Asia, swarms of *A. dorsata* migrate between two or three areas during the year and regularly occupy the same nest sites in each area. So a nest site itself was worth owning and preserving, as well as the large comb that constituted the nest. When full of honey this was more valuable than the nest of any other bee, and great hazards were faced in order to obtain it.

Various peoples hunted for *A. dorsata* nests in high trees, and others collected nests which they knew and owned (Sections 10.24, 15.23). This Section describes the next development: identifying a potential or previously used nest site on a tree and preparing it for occupation by the bees. The person who did this work might thereby become the owner of the tree, the nest site and the nest, which he tended in various ways after the bees built their comb.

I have been told that honey collection was a very old tradition in Sumatra, Indonesia, passed from father to son; the bees were not killed and only part of their honey was taken. In West Sumatra and Riau province the work was done on a moonless night forty days after the bees arrived. In the mountains it was done 'when the nest turns yellow': when most of the brood is sealed – and honey stores are greatest – the young bees (which look yellow) move to the outside of the cluster.

In Lampung Province in southern Sumatra (Figure 15.1a,I), a tree suitable for *A. dorsata* nests was made attractive to incoming swarms. The area surrounding the tree was cleared of undergrowth; the trunk and branches where bees had nested previously were cleared of any parasitic plants, and the branches made smooth. Ownership was finalized in one of two ways. At the base of the tree, the would-be owner either buried the bones of a man who had died a violent death by sword or kris, or he soaked a diamond in water for 24 hours and then poured the water down over the tree from its crown. Once ownership was established, it was heritable.

After nests were built, a circle of thorns was fixed round the tree trunk to prevent Malayan sun bears climbing up it. Tigers and wild boars were also attracted by the scent of the comb, especially if it contained brood, so a scaffold was erected round the tree, and possibly a hut, to protect both the men working and their harvest (Cattenburch, 1864). It was impossible to provide permanent protection against damage by birds; honey buzzards (*Pernis ptilorhynchus*) flew at the comb and pierced it with their powerful beaks until pieces dropped down and could be eaten.

When harvesting honey the owner climbed the tree carrying a flaming torch, a knife usually of wood, a long rope, and a leather or bark bag for the combs. He cut away the lower (brood) part of the comb whose wax was of low quality, then smoked remaining bees off the upper (honey) part and collected this in his bag. When he had taken 6 to 8 combs, he lowered the bag to a companion on the ground. The same procedure was continued until all combs in the tree were taken.

The above information is taken from Cattenburch's detailed study (1864), and de Vries (1994) wrote more briefly in English. There have also been recent reports of *A. dorsata* management in secondary forest on Belitung Island off the south-east coast of Sumatra (Mulder, 1996).

The Nicobar and Andaman Islands (Figure 15.1a,H) lie north-west of Sumatra like outliers from the long chain of Indonesian islands. In Little Andaman Island, some of the Onge traditionally

harvested only part of an *A. dorsata* comb (containing honey), leaving the colony to rebuild the comb and store more honey in it (Dutta *et al.*, 1983). They were able to do this because they had learned that extracts from certain local plants pacified or repelled the bees. In Figure 15.2a the bees have just been repelled from some new comb built in place of honey comb harvested earlier.

In northern Vietnam, Toumanoff (1940) watched an Annamite cut off part of an *A. dorsata* comb containing honey, leaving the rest intact to be harvested a month later. On Cat Ba island, mentioned in Section 10.24, I was told in 1989 that some of the men who found nests of *A. dorsata* did not destroy them or kill the bees, and were able to cut honey comb from the same nest 3, 4 or 5 times in a season. In Kedah state on the north-west coast of peninsular Malaysia, honey collectors also cut honey comb from *A. dorsata* nests 2 or 3 times per season, leaving the brood comb intact (Durno, 1989). This may have been done elsewhere, but is rarely recorded.

18.2 Traditional rafter beekeeping with *Apis dorsata*

The tending of *A. dorsata* nests was developed into a form of beekeeping in two swampy regions in south-east Asia, where the bees nested on trees within a few metres of the ground. One region is a fresh-water lake area of the Kapuas river in western Kalimantan, Borneo, and the other a submerged forest in the Mekong delta, southern Vietnam. The beekeepers made and erected artificial supports as nest sites; these were known as 'rafters' because they sloped like rafters of a house. In 1902 Fougères commented that in Cambodia, apart from people living on the border with Cochinchina (i.e. Vietnam), they did not use rafters but were content to get honey by hunting for nests, so rafter beekeeping was apparently done in one area, but nothing is known about it.

Kalimantan (part of Borneo), Indonesia

In the fresh-water lakes and marsh which form part of the Kapuas river system north of Semitau (Figure 15.1a,J), there was an abundance of flowers for two months after the annual dry season, on high trees and lower bushlike vegetation that grew in the shallow water – especially *Eugenia* and *Carallia* species. The bees migrated in from hills and mountains nearby for this flowering period. The earliest report I know on the use of artificial nest sites refers to this area (Lijnden & Groll, 1851). In trees along the river banks that provided nest sites, people hung a rafter (*tekkong*), a long, slightly hollowed half-pole. This was done in November-December when swarms were due to arrive, and the bees built their combs down from the rafters. After 2 or 3 months, the owners of the trees drove the bees away or burned them, and harvested the honey and wax.

Mol (1933) gave a fuller description. The rafter (*tikung*), made of odourless hardwood, was usually 1.6-2.3 m long. The flat side was hollowed out along its length to provide drainage, and placed uppermost. To fix the pole in a slanting position in a tree, a short U-shaped slot was cut from each end and placed round a supporting branch; the slot was closed with a wooden pin passed through holes made in the protruding prongs of wood. The rafter was left in position permanently, and an incoming swarm was likely to settle on it and build its comb there. Figure 18.2a shows harvesting from a rafter supported on two posts, in 1933.

One member of the community served as head of the rafter beekeeping; he had to know the location of all the rafters and the ownership marks beekeepers carved on them; he also mediated in any conflicts arising, for instance, from alleged theft. At the end of the flowering season two beekeepers would go together in a sampan to collect honey; one climbed into the tree containing an occupied rafter, carrying a torch to drive off the bees, and a watertight basket made of rattan and bark which he fixed just below the comb. He cut the comb from the rafter with a hard wooden knife, working downwards from the upper end of its attachment. The full basket was carried to the sampan and emptied into an earthenware vessel. When the sampan was full it was taken home, where the combs were pressed by hand. (This is similar to a procedure in the Sundarbans forest, Section 10.25.)

In 1933 *A. dorsata* colonies were being kept in this way by families of about 500 fishermen who migrated

Figure 18.2a Beekeeper harvesting an *Apis dorsata* nest on a *tikung* near the ground, Kapuas River Basin, Borneo (Mol, 1933).

into the area for the season and combined beekeeping with fishing; they were probably Melayu (see Rouquette, 1995). Most families owned 40-150 *tikung*, but a few had between 1000 and 2000. The same type of beekeeping was also practised, but with fewer colonies, by native Dayak people, and has been reported along smaller rivers in other parts of Borneo. Colter *et al.* (1995) obtained a little later information in 1990/93 from 9 men and 1 woman rafter beekeepers in the Kapuas Lake Communities, and Rouquette (1995) made further observations. Mulder and Heri (1996) reported in detail the results of a visit to study the system still practised in the upper Kapuas lake region. An individual beekeeper usually owned around 100 *tikung*, and a few owned up to 500, but the annual honey production was probably less than 20 tonnes.

Mekong delta, Vietnam

The earliest reference found to the beekeeping in the Mekong delta (Figure 15.1a,K) is by Fougères (1902). He described the use of a rafter (*perche*), about 2 m long and 10 cm wide with a drainage channel grooved in its upper flat side, but the inclination of the rafter to the horizontal was not mentioned. Harvesting took place in August; it is not clear whether earlier harvests were also taken. In 1898 (the year described) one man might have 100 rafters, 20-40 of them occupied. Both production and prices of honey and wax were lower than in 1879. Figure 18.2b shows a rafter in the Mekong delta supported on two posts, in 1959.

All the honey and beeswax exported from Indochina in 1898 was produced in Cochinchina and Cambodia (15 tonnes of honey, 2.8 tonnes of beeswax); most was from *A. dorsata*, but not all from rafter beekeeping. For Indochina, Vallette (1922) quoted 7 tonnes of beeswax in 1906 and 11 tonnes in 1913, with only a 'little' honey; but he referred to the country as a *pays apicole*.

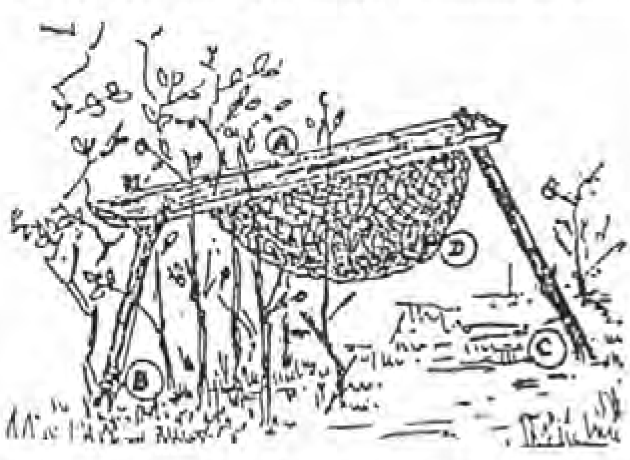


Figure 18.2b Rafter in the Mekong delta with an *Apis dorsata* nest built from it, in a 1959 Vietnamese book on agriculture. **A** Rafter; **B** Post supporting lower end; **C** Post supporting upper end; **D** Nest.

Figure 18.2c New rafter for *Apis dorsata*, ready for erecting, U Minh forest, Mekong delta, 1989 (photo: E. Crane).

The following account of what was found in 1989 is summarized from Crane *et al.* (1993a). In general it corresponded with Fougères's description. In the three southernmost provinces of Vietnam, Minh Hai, Kien Giang and Hau Giang, *A. dorsata* migrates between mangrove forests on the coast and forests of *Melaleuca leucadendron* farther inland which produce much nectar and pollen. The beekeepers lived permanently in the U Minh forest, and did forestry work when the bees were not there. Before swarms were due to fly in, they made rafters of wood from *Melaleuca*, *Areca catechu* or any other odourless wood impervious to water. A straight branch 2.0 to 2.5 m long and 10-25 cm in diameter was split in half lengthways to make two rafters (Figure 18.2c). As in Kalimantan, the flat side of the rafter was placed uppermost, a channel already gouged out along its

Figure 18.2d Fully built *Apis dorsata* comb on its rafter, U Minh forest, Mekong delta (photo: V. Mulder). The bees have been driven off to expose the comb.

length to drain off rain water. Here, the rafter was erected at about 15°-30° to the horizontal, a rectangular or triangular hole being made near its upper end and fixed about 2 m above the ground, over the top of a wooden post. The lower end was supported about 0.5 m lower, in a tree or shrub.

Beekeepers paid great attention to selecting sites for rafters, which were in an area of dense growth of trees 5-10 years old. The upper end of the rafter pointed to the south-east, from which direction a dry wind blew and the morning sun shone. In this direction also, the beekeeper made a clear space by removing undergrowth (see below); in all other directions the rafter was sheltered from sun, wind and rain by low forest growth.

Swarms arrived from coastal mangrove forests in November and remained on the rafters until July, when they returned to the coast. The comb they built (Figure 18.2d) was usually about 1.5-2.0 m long (wide), 0.6-0.8 m high, and up to 10 cm thick where honey was stored, thinner elsewhere. Beekeepers, who reached the nests by boat, quietened the bees with smoke from the root of *Ficus altissima* or fresh leaves of *Melaleuca*; they took a first harvest 4 weeks after the bees arrived. The bees remained at the rafter sites for 8-9 months each year, and up to three further harvests were taken before March. A harvest from one nest was about 6 kg of honey, making about 24 kg in all. Figure 18.2e shows a mid-season harvest. After the end of the season rafters were stored, and before re-use remnants of comb were cleaned off, leaving only a thin layer of wax.

Figure 18.2e Mid-season harvest from the *Apis dorsata* comb in Figure 18.2d (photo: V. Mulder). The upper part of the comb containing honey (right) has been cut away from both the rafter and the lower, dark, part of the comb containing brood (left).

Collectives had been established (in U Minh district, and probably elsewhere), each consisting of 30-50 families. Those in U Minh obtained part of their livelihood from selling honey produced by *A. dorsata* beekeeping, but much less honey was produced (about 150 tonnes annually) than 50 years ago, due to large-scale felling and chemical defoliation of *Melaleuca* during the USA-Vietnam war (1964-75).

Rafter beekeeping with *A. dorsata* is known only in wooded swampy areas, and the combination of circumstances leading to it may have been very unusual. The fact that it exists in the above two areas suggested that it might also have been developed elsewhere. Vincent Mulder, Remy de Vries, Nguyen Thu Hang and I searched past literature in English, French, Dutch and Vietnamese (but not Chinese), without finding further records. Enquiries should be made in other possible areas.

Figure 18.3a *Apis dorsata* colonies in experimental open-fronted hives, Mysore State, India (Thakar, 1973). The bees remained in the hives for at least 3 months.

18.3 Rational beekeeping with *Apis dorsata*

18.31 Frames and partly enclosed hives

The early descriptions of *A. dorsata* beekeeping (Section 18.2) were published in Dutch or French, and none of them seems to have become known in India, where over 80% of the honey and beeswax production was from natural *A. dorsata* nests. In January 1939, the first issue of the *Indian Bee Journal* in Uttar Pradesh contained an article by H. Viswanathan on *A. dorsata*, and also detailed advice from R.M. Muttoo (as Editor) on starting beekeeping with this bee. Muttoo had no practical experience, but devised the idea of using an upper wooden frame, the bottom of which was fixed to the top of a lower frame; the two were to be erected just below a ceiling on which a swarm was likely to settle. The outcome of this idea is not known.

Modest success was obtained with adapted upright box hives whose sides consisted mostly of wire gauze. Parts of one or more sides were removable, and were closed only when the colony was being moved or might abscond (Thakar, 1973; Ahmad *et al.*, 1984); see Figure 18.3a. However, less progress was made with these hives than with the artificial nest sites described below.

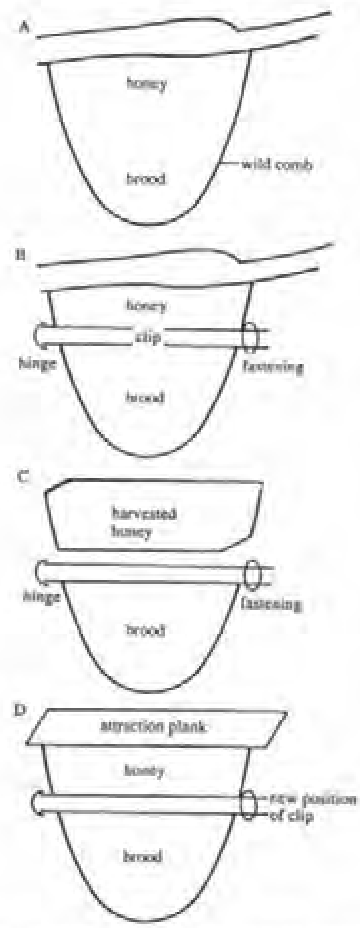


Figure 18.3b Management of *Apis dorsata* using a clip and an attraction plank, India (D.B. Mahindre, in Crane, 1990a). Diagrams A-D are explained on p. 152.

Figure 18.3c *Apis dorsata* combs with their clips, India (photo: D.B. Mahindre). *left* Comb without bees, showing brood cells below, and the clip and honey cells above. *right* Mrs Mahindre holding a colony by its clip, after removal of its honey comb, 1964.

18.32 Artificial nest sites *in situ*

One method of managing an *A. dorsata* nest was described in 1956 by Ghotge from the Rock-Bee Research Station at Ujjain in Madhya Pradesh, central India. At a natural nest site in the open he subdued the bees with a water spray, then fitted a long 'clip' horizontally across the comb so that the part above the clip contained most of the honey; this was harvested leaving the clip with the lower brood area suspended *in situ*.

In the same region Mahindre (1983, 1984, 1988) followed up Ghotge's method, and kept *A. dorsata* colonies for twenty years in the following way, starting with a comb (containing honey and brood) attached to a tree branch (Figure 18.3b,A). A clip was made from a piece of bamboo 5 cm in diameter and slightly longer than the width of the comb, cut in half lengthways, and the two halves hinged together at one end with a piece of flexible leather. At night, the clip was fixed horizontally across the comb, below the honey cells and above the brood nest (see B). In C, the upper part of the comb containing honey has been cut off for harvesting, just above the clip, and the lower part still attached to the clip is ready to be taken to an apiary; D is explained in Section 18.33. Figure 18.3c shows two combs with their clips, and Figure 18.3d some different types of clip.

Figure 18.3d Different types of clip used in India for *Apis dorsata* combs, 1980 (photo: E. Crane)

In a rather similar system, Muthappa (1979) in south India used wooden planks 1.5 m long, 15 cm wide and 2.5 cm thick, smeared with beeswax and juice from *Cinnamomum incus*. He fixed them on tall trees or high rock faces where *A. dorsata* usually nested, and incoming swarms built their combs from the planks. At harvesting time he used a rope and pulley system to lower each plank and its comb to the ground; he cut the comb from the plank with a sharp knife and tied to the plank the lower part of the comb containing brood and pollen, which was hoisted up again. Figure 18.3e shows another pulley system.

Figure 18.3e *Apis dorsata* comb in a clip being lowered to the ground by a pulley system, India (photo: D.B. Mahindre).

18.33 Artificial nest sites in an apiary

Mahindre (1983) progressed a stage further with a rope and pulley system, by moving individual colonies on their combs (each held in a clip as described above) to a shaded apiary. Here, each comb held by its clip was fixed just below an 'attraction plank', a board 25 cm wide smeared on the underside with beeswax. It sheltered the comb, which the bees soon attached to the underside. Planks were fixed horizontally at a convenient height, mostly 6 to 10 m above ground but sometimes only 1 to 3 m. The clip was removed and refixed farther down when the comb was firmly attached to the plank and the bees had stored honey at the top of the comb (Figure 18.3b,D). Mahindre also used Muthappa's method to get a colony to build its comb on an attraction plank. When a comb was fully built from the plank, this was removed to a more convenient location, complete with comb and bees.

Mahindre was able to prevent a colony deserting its comb after it was taken to a new site, by collecting the adult bees and the queen and keeping them in a screen box (similar to those used for package bees, Section 44.31) for 2 or 3 days. He then allowed them to fly out through a small hole close to an attraction plank fixed in a convenient site; they clustered on the underside of the plank and built their comb, and did not desert it. An incoming swarm could be made to settle beneath an attraction plank by a similar procedure. Mahindre maintained up to 150 colonies in apiaries in this way.

It proved possible to transport a comb built from an attraction plank to different honey flows, by fixing the plank in a screen box. The attachment of the comb was wide enough to prevent the comb swaying during transport.

19

The Dwarf Honey Bee *Apis florea*: Tending and Beekeeping

19.1 *Apis florea* as a source of honey

Apis florea is the most user-friendly of the honey bees: its nest is often easily reached and contains relatively few bees, which are likely to be rather gentle. The nest (Figure 4.2a) has only one comb, often built round and below a thin branch of a tree which can be cut off; with care it is possible to carry home the comb and the bees on it, and instal them in a suitable place out of doors. But if the bees are too much disturbed they fly off the comb, and if this is then removed they may build another nearby. So distinctions between the terms hunting, finding, owning, tending and traditional beekeeping are more blurred than when applied to other honey bees.

Some of the bees named as *A. florea* before about 1990 belong instead to a very similar species *A. andreniformis* (Section 3.5), and we do not always know which species was referred to. However, locations where traditional *A. florea* beekeeping is known to have been carried out (Section 19.2) are in the west of the combined range, where *A. andreniformis* has not been recorded.

19.2 Tending *Apis florea* nests, and traditional beekeeping

In a few dry areas, with a very hot summer which other honey bee species were unlikely to survive, forms of beekeeping with *A. florea* were developed locally. Nests might be used *in situ* or in an apiary, and the two procedures are dealt with together. Such beekeeping in the north of Oman in the Arabian peninsula has been described in the past few years. Here, a short account is given of a somewhat similar beekeeping in the Indus basin in Pakistan. Further searches may well show that it existed elsewhere.

19.21 The Indus basin

I owe my knowledge of this beekeeping to Khalid Khan of Peshawar, who introduced me to it in May 1989 when we crossed the Indus to enter the North West Frontier Province, and visited the small bazaar of Khair-a-Abad opposite Attock fort. The beekeeping was carried out on both sides of the Indus river downstream from Attock to Dera Ismail Khan about 250 km to the south, and on both sides of tributaries entering this stretch of the Indus from the west, as far as Bannu. *A. florea* was the only honey bee in these areas, which are surrounded by desert. According to Qatabud-Din (1989), in some parts the bees do not abscond from their nest sites, so colonies could be kept permanently.

When a beekeeper first found a nest, he cut a fairly straight stick (5-10 mm in diameter) about twice as long as the width of the comb where it contained brood. He slit the stick along almost the whole length, leaving both ends intact, and inserted a small stone to keep the slit open. Or he left one end intact and later tied the halves of the other end together. He then clamped the comb between the two halves of the stick, just above the brood area along the line indicated by arrows in Figure 4.2a. The drawings in Figure 18.3b show a rather similar system with an *A. dorsata* comb.

After brushing bees off the honey portion so that they moved down to the brood comb supported by the slit stick, the beekeeper cut the comb just above the stick. He also cut free the original branch supporting the rest of the comb (containing honey) which was his first harvest. In Figure 4.2a the two ends of the (dark) branch supporting the comb are fastened to the (light) wooden rack with string.

If the nest was within say 6 km of the beekeeper's home, he might fix the stick now supporting the brood comb at the site, and return later to harvest more honey. If it was farther away, he carried home the brood portion held in the split stick, and fixed it in a suitable shady tree near his house; he fed the bees, by spreading honey on the top of the stick, since he had taken most of their honey store. The above operations were done in the evening or early morning, or on a cloudy day, as the bees were then less inclined to fly away.

Figure 19.2a *Apis florea* honey comb sold in the Indus valley, Pakistan, May 1989 (photo: E. Crane). The split stick was inserted by the beekeeper when he took the previous honey harvest.

The beekeeper cut the honey comb again in May and October, each time harvesting the portion built round the slit stick and repeating the process described above. His final harvest was taken well before the end of the honey flow (10 days before if the flow lasted a month), so that the bees could store honey for their own use.

Two booths at Khair-a-Abad were devoted to selling *A. florea* honey, and they had a hundred or more honey combs such as that in Figure 19.2a; each weighed about 1 kg and was in a plastic bag. I revisited Khair-a-Abad in early April 1993, and was told about the *A. florea* 'apiaries', for about 200 colonies. In October, at the start of the honey flow in a nearby forest from jujube (probably *Ziziphus mauritania*) the beekeepers collected combs built by recently arrived swarms and set them up in a stockyard from which goats, sheep and other animals were evacuated for the duration of the flow. The combs were placed facing south-east, in rows about a metre apart, the ends of the slit sticks supported on piles of stones. The bees worked the jujube for 2 to $2\frac{1}{2}$ months and then absconded; honey comb was cut only once during this period. The procedure was repeated in May or June when swarms returned to the area and worked the *Acacia modesta* flow.

19.22 Oman

A. florea occurs in and around the mountains near the north coast of Oman, in both cultivated and uncultivated areas. In summer the bees nest in sites shaded from the sun, especially at midday. In winter they choose a sunny site, for instance fixing their combs to the roof of a fairly open east-facing cave in the surrounding desert, where the combs are warmed by the morning sun (Whitcombe, 1984a). Men herding goats in the mountains tended these nests to a certain extent: when they found a comb in a cave they took the part containing honey, and used sticks to prop up the brood part in the comb's original position against the cave roof, so that they could harvest more honey later on. Methods of locating colonies are described in Section 10.4, and ownership in 15.4.

Figure 19.2b Beekeeper in Oman holding a wrapped comb of *Apis florea* he has carried to the entrance of an artificial cave (photo: J.B. Free). The brood part of the comb with the bees on it, supported by a split stick, has been transported wrapped in muslin.

Figure 19.2c The unwrapped colony in Figure 19.2b supported at the entrance to the cave (photo: J.B. Free).

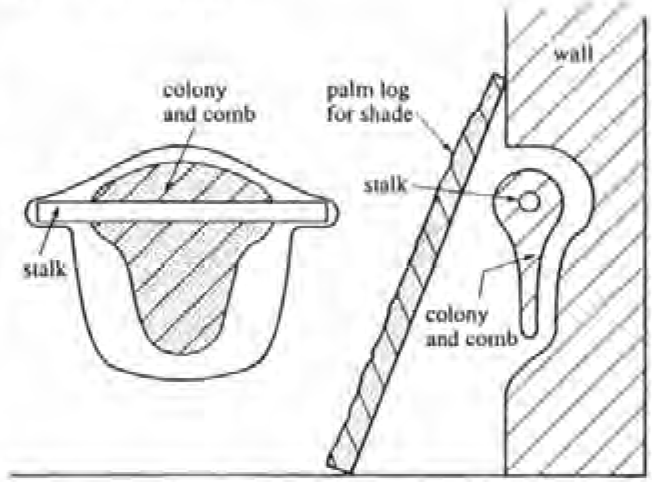


Figure 19.2d Housing an *Apis florea* colony in a wall recess, Oman (Whitcombe, 1984a). Vertical cross-sections (*left*, along the wall; *right*, through the wall) indicate the shape of a typical recess, and of a completed *A. florea* comb built round a split palm frond. The height and width of the recess are about 57 cm, and its maximum depth 19 cm.

In most regions a few individuals practised a form of beekeeping similar in principle to that in the Indus valley. They selected suitable artificial nest sites, for instance under shade in a garden or in a natural or artificial cave. Other sites used were a disused well or pit dug in the ground and subsequently covered, or a ruined building. When a nest was found, the upper part of the comb containing honey was removed, and the lower part with brood was held between the two parts of a slit stick (e.g. a palm frond) about 60 cm long, which were bound together at the ends. The comb was carried to a new nesting place (Figure 19.2b), where the ends of the stick were rested on convenient branches of a tree or other supports as in Figure 19.2c (Dutton & Simpson, 1977; Whitcombe, 1984a).

One beekeeper at Zahib, Sharqiya, an oasis in the north-eastern part of Oman, kept about 30 colonies, probably more than anyone else. A few were in trees, and up to 24 in recesses specially constructed in the inner face of his garden walls (Figure 19.2d). In the cooler winter months the beekeeper moved most colonies about 3 km across the plain, to a wadi where he fixed their supporting sticks on to branches of *Acacia tortilis* and other trees that grew abundantly. He obtained colonies for use in his apiary by collecting nests on a hill about 15 km away.

Oman was little visited by foreigners until the 1970s, and we do not know how old this beekeeping was. Whitcombe (1984a) gave a detailed account.

19.23 Use of *Apis florea* elsewhere

A somewhat similar type of traditional beekeeping was reported from Madina, north-west of Calcutta in Bengal (Kronvall, 1980). Only part of the comb was harvested and the brood area left intact. A photograph shows a colony on such a comb, but not how it was supported. According to Hoekman (1929b), beekeeping was done with *A. florea* in Sri Lanka.

The following practices, in widely separated areas, represent sustainable use of *A. florea* nests rather than beekeeping, and many other such examples can probably be found. *A. florea* is the only honey bee that can survive in Long An, an acid phosphate area in the north of the Mekong delta, Vietnam. Introduced colonies of *A. cerana* failed because of the lack of sweet (non-acid) water. Some farmers collected complete combs of *A. florea* for their honey, and others harvested part of the honey comb two or three times in the season, leaving some for the bees (Mulder, 1990). In several parts of Bangladesh, including one in Narail District in the south-west, people managed to harvest a little honey when the bees nested inside or outside a dwelling house, round one of the wooden poles that formed part of the roof structure. They scraped off some honey comb above the pole and at the sides without disturbing the bees, but did nothing more to the nests (Jensen, 1990).

19.3 Rational beekeeping with *Apis florea*

Apis florea is much easier to manage than *A. dorsata*, but also much less productive, and it was therefore of less interest to man except where it was the only honey-storing bee, or an especially valued one. There seems to have been little incentive to devise more rational beekeeping than the traditional methods described.

Whitcombe (1982) developed a rational hive, in many ways similar to that for *A. dorsata* shown in Figure 18.3a. The bottom bar of an upper honey frame almost touched the top-bar of a lower brood frame, and the frames could be separated. The top-bar of each was suspended from rebates in the side walls of the hive. When the honey comb was filled, it could be harvested and a new frame inserted. The upper frame was in a box covered at the front and back with a piece of wire mesh through which the workers but not the queen could pass. Above the mesh on each side was a full-width entrance block 2 cm wide; except when absconding was likely, this was removed to allow the bees easier passage in and out of the hive. The lower (brood) box had a solid but removable front and back. A horizontal roof was extended on either side to provide some shade.

Part V

HISTORY OF TRADITIONAL BEEKEEPING USING FIXED-COMB HIVES

Chapters 20-32

20

Originations of Hive Beekeeping, and its Early Development in Egypt

A hive is a container used to house a colony of social bees which builds its natural nest in a cavity: the honey bees *Apis mellifera* and *A. cerana*, and many species of stingless bees (Meliponinae). The hive has a flight entrance small enough for the bees to defend, and a larger opening (through which the beekeeper can harvest honey combs) fitted with a closure.

This first Chapter on hive beekeeping deals with certain fundamental issues, including environmental and cultural factors which may have led to hive beekeeping (Section 20.1). The earliest known form of beekeeping was done in Ancient Egypt, and Sections 20.2-20.4 discuss the evidence provided by pictures and writings from about 2400 BC onwards. Our understanding of it is greatly enhanced by observations on beekeeping with traditional hives in Egypt in the 1900s (Section 20.5).

20.1 Originations of hive beekeeping

20.11 Environmental and other factors

The following seem to have been the main positive factors conducive to hive beekeeping.

1. An abundance of bee forage coupled with an insufficient number of natural nest sites for the colonies which the forage could support. In such circumstances existing colonies would grow large and send out swarms, but only those swarms that found suitable nest sites would survive.

2. An increasing need for honey or wax, because the human population was expanding or its standard of living was rising.

3. A human population settled into an agricultural way of life (in the Neolithic period, New Stone Age). Such populations made pots or baskets, and swarms seeking a nest site might occupy those of a suitable size (say 20-40 litres), left lying empty out of doors. Hive beekeeping could be started before the Bronze Age, since metal was not needed for it.

4. The earliest origins of hive beekeeping were likely in warm temperate regions where bee forage was available for most of the year. In contrast, although northern forests provided very good bee forage, many colonies died in severe winters; also there was little incentive to use hives until trees were felled and nest sites became scarce. And there was less incentive in the tropics, where a colony of native honey bees might avoid a dearth period by leaving its nest to establish a new one in another flowering area. These dearth periods were relatively short, and native bees did not develop the same tendency to store honey as bees that had to survive a long cold winter.

Once a people had a knowledge of hive beekeeping they could transmit it to other peoples, in the course of migration from one area to another, or through merchants, soldiers or other travellers. There were probably also many casual attempts to start hive beekeeping – using a container that bees happened to occupy – which were not developed further.

20.12 What determined whether the earliest hives were placed horizontally or upright?

The earliest type of hive known was a horizontal cylinder, and this also became the most widespread type in the world. The first civilizations of the Middle East were in dry areas where there were few trees; the bees probably nested in rocks, and the impossibility of making further rock cavities (unless the rock was very soft, Section 16.4) may have stimulated the early construction of purpose-made hives.

Where nest sites in rock were insufficient for the population of bees, swarms would be likely to occupy empty hives or other covered vessels placed out of doors. (For the bees, a hive or nest cavity must be dark inside, because a swarm initiates comb building only in the dark.) Empty water pots lying on their side might be occupied by swarms, but would have to be broken to harvest honey combs. In the earliest hives we know (Figures 20.3a, 20.3b, 20.3c, 20.4a), the front end was probably closed except for a flight

hole, and combs were harvested from the back which had a removable cover. Harvesting was made easier by smoking the bees from the back of the hive towards the front. Many later hives known were cylinders which were relatively easy to make of mud or clay; they were also stable if placed horizontally, and many could be stacked together. With such a hive beekeepers were also able to carry out an important bee manipulation (Section 20.5): they divided a colony into two by removing a few of its combs containing brood and positioning them in an empty hive with some of the bees so that a new colony was created.

The earliest type of hive in northern deciduous forests was a section of a tree trunk containing a cavity in which bees had nested, and it was placed upright like the trunk itself. In these regions bees could benefit from occupying an upright cavity rather than a horizontal one, in that they stored honey above the brood nest, and this provided a thermal buffer which reduced the colony's rate of heat loss. No evidence seems to have been found that a horizontal cavity is advantageous to the bees in a hot climate.

Winston (1993) participated in measuring nearly a hundred natural nest cavities of Africanized bees in French Guiana, Peru and Venezuela in the South American tropics. Horizontal and upright cavities had a similar size, and the latter were mostly less than 40 cm high. But nests in upright cavities were usually larger and contained more bees than those in horizontal cavities. The above refers to *Apis mellifera*. In Japan, Nakamura (1996) found that *A. cerana* colonies used deep (long) combs more compactly, with fewer unused cells, than shallow, wide combs.

Ruttner (1979a) showed examples of horizontal and upright hives in many localities.

20.2 Hive beekeeping in relation to the earliest civilizations

As pointed out by Clark (1942), the fact that a people used honey or beeswax does not show that they kept bees in hives. Large amounts were obtained from natural nests, and much was transported over long distances even in early times. Hive beekeeping could, however, have been initiated by settled people who lived at a fairly primitive stage of social development, when and where there was a shortage of natural sites for bees' nests (Section 20.11). In an organized civilization, the hive beekeeping could be developed into a structured industry, and surviving early records are more likely to come from such a civilization than from a scattered rural population.

Many fundamental discoveries and developments originated within the approximate latitude range 25° to 37°N, in the first great civilizations which grew up along rivers. Our earliest knowledge of hive beekeeping with *Apis mellifera* (or in China, *A. cerana*) is as follows.

Civilization River	*Started approx.*	*Approx. latitude*	*First known record of hive beekeeping*
Mesopotamia Euphrates/Tigris	–3500	30°-37°	–700s, with bees first brought from mountains
Egypt Nile	–3100	25°-32°	–2400 (may have existed by –5000, Section 20.7)
Indus valley Lower Indus	–2500	25°-30°	none known (cavity-nesting bees not present?)
China Yellow (Hwang)	–2200	30°-35°	between +25 and +150, or between +158 and +167

Bees are also known to have been kept in hives by somewhat later civilizations, one in Asia and one in the Americas. The Hittites lived on the Anatolian plateau in Asia Minor (*c.* 38°-40°N), where the hive bee is *A. m. anatolica*. Their civilization started about –1800, and the text of laws on the theft of swarms and hives, found in Bogazköy (Section 21.2), dates from about –1500. In Mesoamerica (between 15° and 22°N), the Maya people kept one of the native stingless bees in hives at least from the Preclassical period of their civilization, between 300 BC and AD 300 (Section 30.21). This beekeeping and that in Ancient Egypt are comparatively well documented.

In Egypt, the honey bee (*A. m. lamarckii*) was already important enough by 3100 BC to be included in the titulary of the King of Egypt (Figure 6.3c), and known illustrations of hive beekeeping date from about 2400 BC. We have no knowledge of earlier hive beekeeping elsewhere.

In Mesopotamia, where many important cultural developments originated, the use of honey was referred to on a Sumerian clay cylinder from about 2450 BC (Section 54.32), and beeswax was used for lost-wax casting from about the same time. Both honey and wax could have come from mountains to the north near the present Iraq/Iran/Turkey borders, which still have a rich beekeeping tradition. The first known record of hive beekeeping in Mesopotamia is dated to the mid-700s BC, when a ruler brought bees, 'which no one among my forefathers had seen ...', 'down from the mountains' (Section 21.1). Mesopotamia itself was an alluvial plain with no trees except palms, not much stone or rock providing nest sites for bees, and no bee-friendly delta such as that of the Nile on the Mediterranean coast in Egypt. I think it

likely that honey bees could hardly survive in the wild in Mesopotamia because of the intense heat, and a lack of nest sites and possibly of forage. Recent measurements in the Baghdad area show that maximum shade temperatures at hive sites could rise to over 50° in the hottest months (Elmosa & Al-Rubae, 1972), and in 1978 Abdellatif found no beekeeping in southern Iraq. Wax moths and bee-eaters caused excessive damage to bees, and the relative humidity was only 5%; although queens laid eggs, these did not hatch. The ruler who brought bees down to the plain in the 700s BC provided hives, and the 'gardens of the town' where he put them would have given shade, water and forage.

We know nothing of any beekeeping in the civilization of the Lower Indus valley which lasted from about 2500 to about 1700 BC. The cavity-nesting honey bee of the region was *A. cerana*, but this part of the valley may have been too dry and hot for it to survive, and if so hive beekeeping would have been impossible. *A. cerana* was also the hive bee in the Yellow River basin in China, where the climate was more suitable; hive beekeeping is indicated there in records dated to between AD 25 and 150, and more certainly between about AD 158 and 167 (Appendix 1).

20.3 Beekeeping in Egypt during the first twenty dynasties, to 1085 BC

The chronology in Table 20.3A covers the periods discussed in Sections 20.3 and 20.4.

20.31 Old Kingdom, *c.* 2686-2181 BC

The stone bas-relief shown in Figure 20.3a, made about 2400 BC during the Old Kingdom, provides the earliest known evidence of hive beekeeping. It was found in the sun-temple of King Ne-user-re at Abu Ghorab, about 1 km across the sand from his pyramid and adjoining funerary temple which were accessible from the Nile by the angled Causeway of Unas; all these buildings are a few kilometres north of Saqqara. The bas-relief was part of a series of illustrations in the 'chamber of the four seasons', and showed details of honey harvesting and honey hand-

Table 20.3A

Chronology of finds relating to hive beekeeping in Ancient Egypt, and of some historical events

All dates are BC, and are approximate; dynasties are entered in brackets

The general chronology is based on David (1975).

Date	*Site of archaeological find or record*
5000 to 3100	**Predynastic period**
3100 to 2686	**Archaic period (1-2)**
3100	unification of Lower and Upper Egypt as far as the 1st Nile cataract, under Menes/Narmer; capital Memphis established
2686 to 2181	**Old Kingdom (3-6)**
2400	(5) sun-temple of King Ne-user-re, Abu Ghorab, stone bas-relief (Figure 20.3a)
2350	(5) causeway of King Unas, Saqqara, fragments of stone bas-relief also show beekeeping
2400/2133	tomb of Memi, containing 36 cylindrical jars; see text
1991 to 1786	**Middle Kingdom (12)**
1900	(12) Kahun settlement, Fayum, clay cylinder
1567 to 1085	**New Kingdom (18-20)**
	(from 18, 1567 to 1320) lost-wax metal casting practised
1450	(18) tomb 100, of Rekhmire, with complete wall painting (Figure 20.3b)
1450	(18) tomb 73, fragmentary wall painting (Figure 20.3c)
1450	(18) tomb 101, wall painting in which honey is offered to Pharaoh (Figure 54.3a)
1400	(18) honey feast cakes for children, Deir-el-Medina (Figure 47.3a)
1400	(18) tomb 69, wall painting shows the offering of jars of honey
1400	(18) beeswax figurines, also official stamp for marking honey jars
1350	(18) honey comb in tomb, Deir-el-Medina (Figure 20.3d)
1200-1085	(20) includes Ramesses III (1198-1166)
1085 to 332	**later periods (21-31)**
664-625	(26) tomb 279, of Pabesa, painted relief (Figure 20.4a)
304 to 30	**ruled by Ptolemies from Greece**
200s	records from Zenon, quoted in text
30	**Roman province**

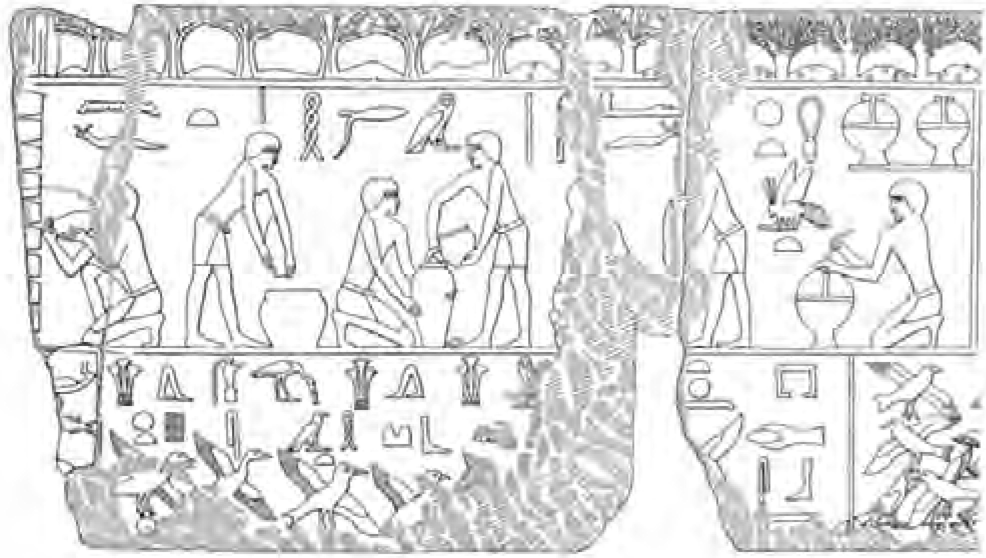


Figure 20.3a Stone bas-relief from the sun-temple of Ne-user-re, Abu Ghorab, Lower Egypt, c. 2400 BC (drawing: Egyptian National Museum Catalogue). The earliest known representation of beekeeping (with honey handling on the right), now in the Egyptian Museum, Berlin.

ling. What remains of this scene includes, on the left, one end of nine horizontal hives at which a kneeling beekeeper is working. The incurved shape is considered to indicate that the hives were made of fired pottery (Hassan Khattab, 1988), and pottery was already known in Predynastic Egypt. The hieroglyph above the beekeeper reads *nft* 'to create a draught, or current of air' (Quirke, 1989), and he is probably blowing smoke from a smoker (shown between himself and one of the hives) to drive bees off the combs to be harvested. I examined the bas-relief, now in the Egyptian Museum in Berlin, but did not learn any more about the beekeeper's action, and we do not know the shape of the missing parts of the hives.

During excavations of the Causeway of Unas (c. 2350 BC) in the 1940s (*Chronique d'Égypte*, 1938), a relief was found which also showed activities through the seasons, with a small fragment of a beekeeping scene similar to that in Figure 20.3a. It was mentioned by Keimer (1957), but no description or drawing has been published (Leclant, 1968, 1989).

Models were sometimes made for furnishing tombs, and 36 coarse pottery jars from about 2400-2133 BC, found in the tomb of Memi in El-Hawawish, Saqqara, could possibly have been hive models (see Crane & Graham, 1985). The same is true of an older jar in the Agricultural Museum in Dokki, found in Abu Armory (Nag Hammadi) and dated to about 3400 BC; it is about 34 cm long, and its diameter widens from about 7 cm at its closed end to 10 cm at the mouth. But nothing is known to connect these with bees.

20.32 Middle Kingdom, c. 1991-1786 BC

Kahun, dated to about 1900 BC, was a workmen's town in the Fayum oasis about 100 km from Saqqara. A cylinder of coarse clay was found, inside which were a small lump of beeswax (identified by gas-liquid chromatography), pollen grains, and part of the hind leg of a honey bee (David *et al.*, 1984). The cylinder is 38 cm long, 9 cm in diameter at one end and 7 cm at the other (internally 6 cm and 1 cm); its walls are thickened towards the narrower end. It might conceivably have been another model of a hive.

20.33 New Kingdom, c. 1567-1085 BC

Much more is known about beekeeping and the honey produced during the New Kingdom, and both are dealt with here.

Beekeeping

The wall painting in Rekhmire's tomb (Figure 20.3b) is the most informative of all the known beekeeping scenes from Ancient Egypt, and also the best preserved and the most beautiful. It can be seen in its full fresh-looking colours near the entrance to the tomb, which is open to the public.

The three short cylindrical hives have a front rounded end, shown closed but probably containing the flight entrance. They are made of dried mud (shown purplish-grey) and are supported on a mastaba or platform of the same colour. Beekeepers are working from the back of the hives. One man holds the open smoker (but is not at the moment directing the smoke by blowing), while the other reaches

Figure 20.3b Wall-painting in tomb 100, of Rekhmire, West Bank, Luxor, Upper Egypt, c. 1450 BC (Davies, 1944). See text.

across the platform shelf to remove combs from the centre hive. The round shape of the combs already harvested shows that these had been built across the width of the hive, not along it or diagonally. By watching traditional beekeepers at work today one can see how this is achieved (Figure 20.5d).

The reconstruction of a much damaged wall painting of about the same date in tomb 73 (Figure 20.3c) shows two beekeepers working singly at a stack of hives (5 above and 6 below), each with a smoker. The hives are described as lead-coloured, so were probably of mud. In the reconstruction, their sides are incurved towards each end, but much of the original is missing.

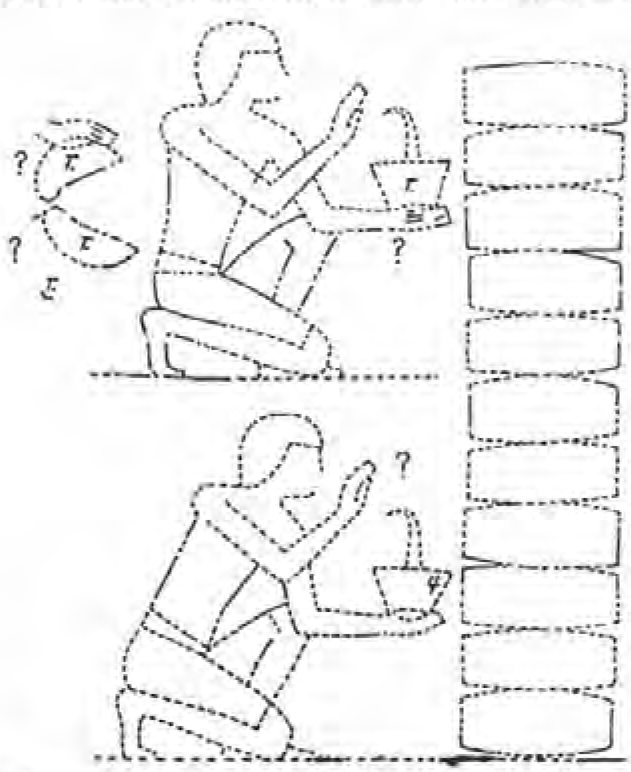


Figure 20.3c Less well preserved wall painting which shows two beekeepers harvesting honey, in tomb 73, West Bank, Luxor, Upper Egypt, c. 1450 BC (Säve-Söderbergh, 1957). Reproduced with permission of the Griffith Institute, Ashmolean Museum, Oxford.

A separate official was responsible for beekeeping during the New Kingdom. In a 19th-dynasty papyrus from Luxor, now in the Ashmolean Museum in Oxford, a scribe complained of two beekeepers who had made inadequate returns about their honey production. One of them still continued working although he had been dismissed, and the scribe urged his superior to take firmer action.

Honey

Figure 20.3b shows fairly large-scale honey handling, although only three hives are shown. The production line moves from right to left, with two dishes piled with combs from the hives, then probably six tall and four shorter large storage jars, as well as two large jugs. Two men are sealing the jars with mud or clay 'taken from a prepared heap' (Davies, 1944), and another two are sealing a pair of smaller dishes. I learned about this last operation in 1980 in Indian Kashmir, where comb honey was sold in coarse pottery dishes (Figure 29.5d) which looked identical to those in Figures 20.3b and 54.3a; as in Egypt, the inverted upper dish was sealed on to the lower one with mud.

Rekhmire, whose tomb contains the painting in Figure 20.3b, was Prime Minister during the reign of Tuthmosis III. One of his duties was to receive offerings at the temple on behalf of the Treasury: cereals, honey and all other 'valuable products'. He stamped them according to their quality, and an official stamp from this period in the Agricultural Museum in Dokki, showing four bees, was used to mark seals on vessels containing honey. Grading was according to purity and colour:

- *stph*: honey (of a good kind, pure), which was rather light in colour
- *deshert*: honey from the desert, rather red in colour

- *pw-g, mh-tt*: designations which cannot be translated but may refer to degree of purity or plant origin.

In the 1400s BC Rekhmire's daughter gave a party at which a love song containing the following passage was performed (Cottrell, 1955): 'The little sycamore, which she hath planted with her hand, it moveth its mouth to speak. The whispering of its leaves is as sweet as refined honey. How charming are its pretty branches ....' Figure 47.3a shows 'feast-cakes for children' which contained honey, from this period.

There have been several dramatic reports of finding honey in Ancient tombs, but analysis has not always established that the substance found was honey. The contents of an alabaster vase in the tomb of the parents-in-law of Anemophis III was shown by analysis to have been castor oil instead of honey. A jar stamped *stph* from the tomb of Tutankhamun (*c.* 1340 BC) probably did contain honey, although too little remained to allow confirmation (Leek, 1975).

Figure 20.3d Bowl from a tomb in Deir-el-Medina, West Bank, Upper Egypt, c. 1350 BC; SMPK 12987, by courtesy of the Egyptian Museum, Berlin (photo: I. Jung-Hoffmann, 1990). The bowl still shows the impression of a honey comb it contained.

Some other samples had deteriorated, but were confirmed to be honey by identifying pollen grains in them. Honeys from the Middle and New Kingdoms in the Agricultural Museum, Dokki, contained pollens from lucerne and another legume, a brassica, a desert plant, *metnan* from Sinai, and rose (Hassan Khattab, 1988).

In a tomb dated to about 1350 BC, a piece of honey comb was found in a small shallow bowl, and this retained the impression of the bees' cells (Figure 20.3d) even after the honey had been reduced to a 'dark brown mass'. Zander (1941) identified pollen grains in this sample as mainly from wild and cultivated trees now unknown in Egypt, including *Mimusops schimperi* (Sapotaceae) and the zachun tree (*Balanites aegyptica*) which produces oil and edible fruits.

From the Predynastic period onwards, plants had been freely imported into Egypt, clover and flax probably during the First Dynasty. A tomb at Hawara (26th dynasty, 664-525 BC) contained flowers and leaves of clover, flax and other nectar-producing plants which included bay laurel, castor oil (*Ricinus communis*), currant, marjoram and peach, also roses (Murray, 1963).

Painting no. 4575 in the Agricultural Museum at Dokki shows honey combs and lotus flowers.

20.4 Beekeeping in Egypt during later periods, 1085 BC to AD 16

The incised and painted relief shown in Figure 20.4a is in the tomb of Pabesa (279); he was a house-steward during the reign of Psammetich I (664-610 BC) in the 26th Dynasty. In 1978 the tomb was unsealed so that I could visit it; the relief is on a pillar in a small open courtyard. The bees appear to fly from the front of the hives, and the beekeeper is kneeling at the back. A further stack of hives was probably depicted on the extreme right, since four hive ends can still be seen, but the rest was broken off – reputedly by soldiers of Alexander in 332/331 BC. The hives, painted bluish-grey as though of mud, are the least regular in shape of any discussed here.

After the end of the Late Period (525 BC), Egypt was ruled by Ptolemies from Greece until 30 BC. Records by Greek officials throw light on beekeeping practices then, and Chouliara-Raïos (1989) published many of them. Around 250 BC, probably one autumn, some beekeepers were desperate for the return of donkeys borrowed from them, so that they could move their hives away from their present site which was due for irrigation flooding, and they sent

Figure 20.4a Incised and painted relief showing a beekeeper at hives, and another above handling honey, in tomb 279, of Pabesa, West Bank, Luxor, Upper Egypt, 664-625 BC (photographer unknown).

a petition to Zenon, an official in the Fayum oasis (Edgar, 1928; Ransome, 1937). A fragmentary papyrus of 8 October 256 BC has an entry beginning: 'The 5000 beehives are ...'. Another letter, written by two Greeks in Egypt on 26 July 240 BC, included the statement: 'We owned already under the present King's father 1000 hives, which were leased out.' A petition was submitted in September AD 16: 'to Herostratus, the strategus, from Heraclius and Onnophis, both sons of Sarapion, who are among the beekeepers of the city of Oxyrynchus. We (together with the sons of Heraclius) possess 487 beehives, of which we had 87 in the village of Toka ....' The writers went on to declare that their stock had been wilfully destroyed by sealing up the hives (Crane & Graham, 1985).

Aristophanes of Byzantium (*c.* 200 BC), who was in charge of the great library in Alexandria, said that 'bees sting and drive away those who approach them wearing perfumed oil, as if the oil was an enemy. For this reason indeed people try to approach them unanointed, and in Egypt even with shaven heads, in order that no moisture of oil remains.'

20.5 Traditional beekeeping in Egypt in the 1900s

In 1964 85% of the hives in Lower Egypt and 94% of those in Upper Egypt were still traditional ones, horizontal cylinders of sun-dried mud (Lotfi, 1988). Native honey bees (*Apis mellifera lamarckii*) were kept in them, although introduced European honey bees were used in modern hives. The traditional beekeeping, with an unbroken history for over 4000 years, shows certain remarkably advanced features which were probably present in Ancient times. Most of the description below is summarized from the following: Mellor's (1928) paper on Lower Egypt, my own observations during two visits to Lower and Upper Egypt in 1978 and one to the delta in 1988, and information from Dr Rashad, Dr Atallah, Dr El-Badawi and Dr Mazeed. Mellor quoted the length of the traditional hive as about 140 cm, and external and internal diameters as 22 and 17 cm, respectively. Hives I measured in Upper Egypt were 120 cm long with an external diameter of only 15 cm. (In 1985 Dr El-Banby told me that even in a wide movable-frame hive the local bees never built more than 5 combs, occupying a width about 17 cm.)

We do not know how hives were made in early times, but Egyptians were expert in using mud for construction purposes. In the 1900s, a mat (*sedda*) was first laid on the ground; it was constructed from parallel reeds or other straight plant stalks, tied together with fibres in the same manner as chestnut paling (Figure 20.5c,1). Mud was made by mixing water with fine clay soil (free from salt and any particulate matter), to which fine straw chaff (*tibn*) might be added. It was spread evenly over the *sedda* (Figure 20.5a), and the whole rolled up – with the mud layer inside – round a core of bamboo sticks. It was left to dry for about 10 days, the *sedda* and sticks then removed, and the surface of the mud smoothed off inside and out with a mixture of mud and cow dung (Figure 20.5a,D). Two round end-closures were also made of mud, and a flight entrance pierced in the front closure, usually near the top as in Figure 20.5b. The white marks seen in this Figure indicated the state of the colony: they were made with lime-

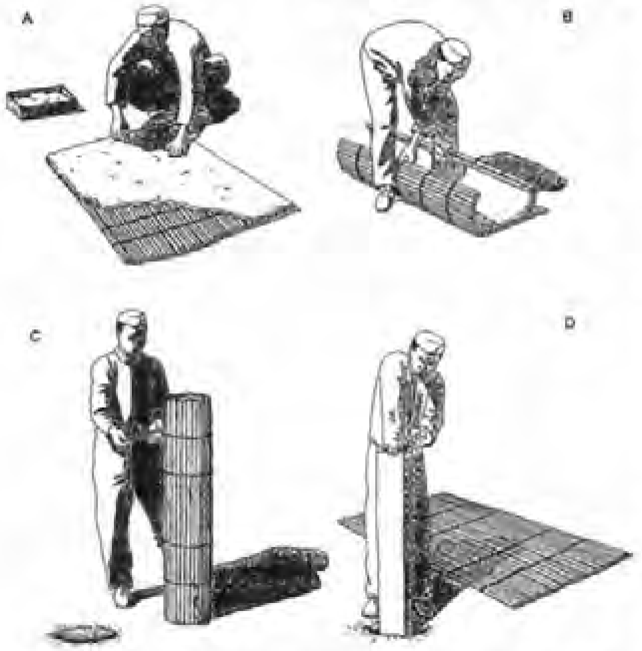


Figure 20.5a Making a traditional Egyptian mud hive, early 1900s (from Mellor, 1928). **A** Spreading mud on mat (*sedda*); **B, C** Rolling up and securing; **D** After drying, and removing the mat, the hive is smoothed inside and out.

wash; black marks would be made with a piece of the charred cow dung cake (*saha*) used for smoking the bees.

Hives were formed into a stack, which might contain up to 1000 but more commonly about 400. To make a stack, perhaps 60 hives were placed on the ground, parallel and juxtaposed; a second row was placed on the first, each hive in the hollow between two in the bottom row. Further rows were added, and spaces between hives filled in at the back and front with straw, over which mud was smeared by hand. The hives were not strong enough for the lowest row to support more than about eight tiers, and most stacks had six or seven; Figure 20.5b shows part of a completed stack. In 1978 in Assyut Governorate, when I was travelling north on the main road beside the Nile, a rough count of hives sited beside the road gave (per 10 km): 2400, 2600, 600, 4200, 0, 4600, 400 hives, a total of 14,800 in 70 km, and on average about 300 per stack. Lotfi (1988) reported nearly 57,000 traditional hives in Assyut in 1964.

Honey was harvested from the back of the hive, using equipment shown in Figure 20.5c which was almost all of metal by the 1990s. The end-closure was opened with the key (7), and a piece of smouldering cow dung placed inside, near the outside comb. When the smoke had driven the bees off this comb, its attachment to the hive was severed with the cutter (6), and the comb brought out of the hive on the flat blade of the tool (5). The process was continued with other combs, but the final few combs were left untouched so that the queen was unharmed and the colony could continue. Any parts of combs that contained sealed brood were propped upright on the hive floor, so that the brood could develop into adult bees.

A hive was also opened from the back to insert food, to remove empty combs that might attract wax moths, or to cut out unwanted queen cells in order to prevent swarming; it was opened from the front to inspect the brood nest or to divide colonies. The beekeeper cut out queen cells (before virgin queens

Figure 20.5b Stack of 400 cylindrical hives of sun-dried mud near Assyut, Upper Egypt, 1978 (photo: E. Crane). See text.

Figure 20.5c Equipment used in traditional Egyptian beekeeping, mid-1900s (photo: Fario Mounir). On an extra-wide mat for making hives (*sedda*) and a bee veil with metal wire insert (*rokah*) the following tools are laid out (starting at top): Ladle (*makah*, *capsha*); Scraper (*showka*), also short *showka* used when opening a hive from the front; Sharp flat-bladed tool (*sadif*); Cutter (*kassafa*); Key (*khorab*, *muftah*).

emerged from them) early in the morning when the sun was low in the east. He used a piece of metal to reflect the sunlight along the length of the hive, which was always north-south, so that he could see any cells along the lower edge of a comb, and cut them away with the tool (6) in Figure 20.5c.

At swarming time, a colony of most races of *A. mellifera* produces only a few queen cells – not more than 10 or 20 – but a colony of *A. m. lamarckii* in Egypt produces between 50 and 250, and many young queens may live together in a colony until swarms issue from it. The same is also true of *A. m. syriaca* to the east (Israel, Jordan, Lebanon, Syria), *A. m. intermissa* along the North African coast as far east as the Libyan desert, *A. m. adami* in Crete and *A. m. sicula* in Sicily. However, only with *A. m. lamarckii* in Egypt have I heard of beekeepers 'calling' queens to find out which colonies contained young ones, and were thus ready to be divided into two.

The following procedure was used for dividing colonies in both Lower and Upper Egypt according to Mellor (1928), but Dr M.M. Mazeed told me in 1988 he found it only in Upper Egypt. It was done during the swarming season at the end of February or in March, in the early morning while the bees were still in the hive. The beekeeper smoked the bees from the

Figure 20.5d Comb taken from a traditional hive, fixed on a forked twig, ready for replacement, 1980 (photo: E. Crane).

back (as when harvesting honey), so that they (and any young queens) were crowded together at the front. Then he put his mouth to the flight entrance at the front and 'called' the bees several times. The call, which was described as *kak, kak*, or *kak, kak, kaak*, or *ee, ee*, imitates a sound known as piping, made by young virgin queens; frequencies of the sound are discussed at the end of Section 20.6. Any virgin queens free in the hive or still in their cells were likely to reply to his 'calling', in which case the beekeeper knew that the colony would swarm unless he took action. He marked each such hive with a black line, and prepared an empty hive to receive the 'artificial swarm' he would make. Then he removed three combs (with bees) from the marked hive, and used a forked twig, *shebah* (Figure 20.5d), to fix each across the empty hive near the front, at their correct distance apart. He smoked all the bees remaining in the marked hive off the combs at the front, and then filled his ladle (Figure 20.5c,3) with bees and put them in the new hive, two or three lots altogether. He tried to include the old queen, but in case he had missed her he included at least 10 of the virgin queens.

20.6 How hive beekeeping was probably done in Ancient Egypt

General practices

The beekeeping scenes from Ancient Egypt (Figures 20.3a, etc.) were designed to show honey harvesting and handling; they included honey vessels of various types, and probably some strainers, but no beekeeping equipment or tools apart from hives and a smoker. All objects were of earth materials; there

were none of wood, animal skin or plant fibres, or of metal. Ancient Egyptians knew bronze and iron, although not how to produce them, but almost all the beekeeping operations described in Section 20.5 could have been done using the hands, or a sharp stone fixed to a long handle. The open smoker in Figure 20.3b had its counterpart in some used farther west in North Africa, although in Egypt itself a piece of dried cow dung is now often used without a container.

All the hives in the four early scenes (from about 2400, 1450, 1450 and 625 BC) could have been made by a building-up process such as coiled-work, whether or not they were fired. Hives appear to have a flat end at the back which could have been closed with a disc of dried mud, clay or other material, as now. In all the scenes the beekeeper kneels, and works from the back of a stack of hives on a low shelf or on the ground, as now. In the latest scene (625 BC) bees are shown flying in front of the hives. In the 1900s Egyptian hives were longer and narrower than those portrayed in Antiquity, and all or most were made by the rolling technique shown in Figure 20.5a.

In summary, the following characteristics of Ancient Egyptian beekeeping seem to have been the same as those of present-day traditional Egyptian beekeeping. Hives with a round cross-section were made of earth materials, and placed horizontally. The beekeeper constructed a stack of hives and worked at the back of it, protected from bees round the flight entrances at the front. He removed honey combs after opening a hive from the back and, even in the earliest scene known, he smoked the bees to pacify them. He arranged that bees should build (round) combs *across* the hive, perhaps by the method used today. A colony could thus be divided into two at swarming time, each new colony having a queen. Finally, it is possible that a beekeeper could establish the readiness of a colony for division by 'calling' the young queens in it, as was done in the 1900s.

'Calling' queens

Dr M.J. Raven in the National Museum in Leiden, Netherlands, sent me details of a papyrus (Cat. I 384) from the period 404-343 BC, known as the *Myth of the eye of Re (Ra)*. It consists of popular stories somewhat after the style of Aesop's *Fables*, and quotations here are from a French translation by Cemival (1988).

In a passage discussing appropriate homes for different animals – for instance a barn for a cat with kittens – there is a sentence: 'One does not build a royal palace for the honey bee. A hive of dung is better than a hive of stone [like a barn] ... The house of the bee is effectively an arrangement of combs, a place suitable for storing honey ... It is more pleasant for the bees beneath the honey combs.' After further comparisons: 'If the beekeepers go to awaken the cells(?), if they call them with a reed flute, it is because a reed flute excited Nut in Ancient times.... If one wants to write the word honey, one draws Nut holding a reed in her hand.' (Nut was the sky-goddess, and according to one of the official legends the sun-god Ra was born from her every morning.) It is possible to interpret the passage as referring to the calling of queens still in their cells (end of Section 20.5), and listening for a queen's reply, which would show that young queens could be used to make new colonies. The Museum at Leiden also has several short reed flutes from Ancient Egypt, of a type that could have been used.

A sentence from around the 700s BC in the Hebrew scriptures may or may not refer to this practice: 'On that day the Lord will whistle for the fly from the distant streams of Egypt and for the bee from Assyria' (Isaiah 7.18, NEB).

In 1956 Woods analysed sounds made by piping queens of European *A. mellifera*. A rather pure tone was produced: 180 Hz by a queen still in her cell, before her body had hardened; 300-350 Hz when she had just emerged from it; 350-380 Hz when she was a few days old. Although the fundamental was inaudible to the human ear even 15 cm from the queen, harmonics (1500 Hz for a mated queen and lower for a queen in her cell) could be heard outside the hive and even 6 m away. All frequencies measured showed considerable variation. No similar observations on queens of the Egyptian honey bee are known.

20.7 When and why did hive beekeeping start in Egypt?

The Kingdoms of Upper and Lower Egypt were united around 3100 BC, and the First Dynasty was founded under Menes/Narmer (Table 20.3A). From that time until about 300 BC, the titulary of the King of Egypt included the hieroglyph *nswt-bit* (He of the Sedge (Reed) – He of the Bee)*, and Figure 6.3c shows some examples from the period of the first two Dynasties, 3100-2686 BC. Hassan Khattab, Director of the Agricultural Museum at Dokki, concluded from his studies (1988) that since the bee was of sufficient importance to be included in the King's titulary by

*It is customary to regard the bee as representing Lower Egypt – the delta and as far up the Nile as Saqqara – and the reed Upper Egypt, but this distinction dates only from the Ptolemaic period (Quirke, 1989).

21

Traditional Hive Beekeeping to the East, South and West of the Mediterranean

21.1 Lands to the east: early records from Mesopotamia

Some of the earliest civilizations developed in Mesopotamia, between the rivers Tigris and Euphrates which rise in eastern Anatolia and join near their mouth in the Persian Gulf. Although many technological developments first originated there, Section 20.2 suggests that the use of hives may not have been among them, for environmental reasons. The earliest known record of hive beekeeping in Mesopotamia is in an Assyrian relief (Figure 21.1a) erected in Suhu on the middle Euphrates. It shows the ruler Shamash-res-usur, who lived some time between 781 and 745 BC, and includes the passage:

> I am Shamash-res-usur, Governor of Suhu and Mari. Bees which gather honey, which no one among my forefathers had seen nor brought down to the land of Suhu, I brought down from the mountains of Habha and established in the town Gabbari-ibni [a town he had founded]. They collect honey and wax. I understand how to do the melting out of the honey and wax, and the gardeners also understand it. Any later person who appears, let him ask the old men of the country whether it is true that Shamash-res-usur the Governor of Suhu introduced bees. (Saggs, 1984)

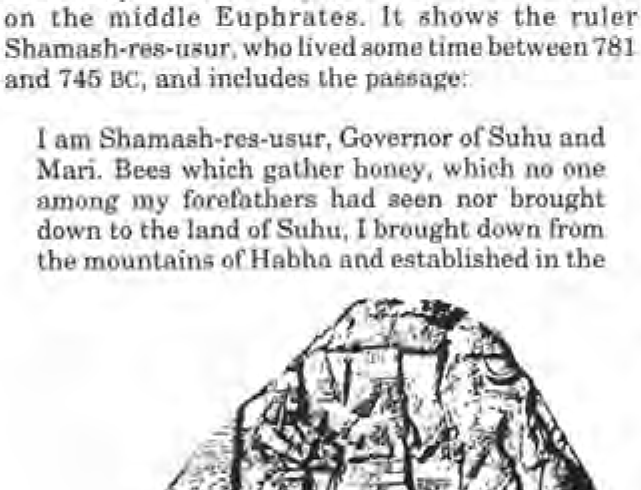


Figure 21.1a Relief from the mid-700s BC showing Shamash-res-usur, the ruler of Assyria who first kept bees there (Istanbul Archaeological Museum). The inscription (see text) records the first known transport of bees for use in beekeeping.

'The melting out of the honey and wax' may have referred to separation of wax and honey by heating, or to extraction of wax from comb residue after most of the honey had been removed by straining. The transport of bees and placing them in gardens implies the use of hives, and the comment that bees had not previously been seen in Suhu suggests that wild colonies did not survive there; on the other hand colonies cared for in suitably placed hives might well do so, and produce honey. It also seems to imply that hives were used by the people of Habha in the mountains; these were in south-eastern Armenia or north-western Kurdistan (Neufeld, 1978), and this area, south of the point where modern Iraq, Iran and Turkey meet, has a rich beekeeping tradition today (Section 21.4).

Section 20.6, which refers to the beekeeper 'calling queens' in a late Egyptian period, also quotes a reference (700s BC): 'the Lord will whistle for ... the bee from Assyria.'

In Sumer in Mesopotamia, honey was used in medicine and as an offering before 2000 BC (Sections 47.41, 54.32), and beeswax was used for lost-wax casting of metals (Section 49.42). Babylonians used honey in medicine and in rituals (Leibovici, 1968), and ritual uses were referred to in the time of Hammurabi, around 1500 BC (Deerr, 1949). Perhaps the honey and wax came from the mountains to the north. Herodotus (485-425 BC) reported that palm trees in Babylonia 'yield fruit from which the people make bread, wine and honey' (I.193), but this 'honey' was probably made from pressed dates.

Babylonian Talmud

The earliest mentions found to hives and beekeeping in Babylonia are incidental references in five passages in the Babylonian *Talmud*, a collection of Jewish laws, traditions and commentaries compiled about AD 500 but based on earlier material.

Whether or not it was sinful to harvest honey on the Sabbath (*Ukzin* 3.10) depended on whether 'a bee hive counts as immovable property', and different Sages held different opinions. If a hive was immovable property, but not otherwise, a man who 'scraped honey from it on the Sabbath' was liable to a Sin-offering. Scraping combs from the hive to break their attachments to it was a usual harvesting method.

Ukzin 3.11 referred to honey combs 'after the bees are smoked out', and another passage said 'after the honey combs have been broken'. Both practices were usual in traditional beekeeping elsewhere.

Oholot 9 is a tractate dealing with the uncleanness of an object (including a hive) that is in the proximity of a tent or house containing a corpse. The alternatives considered throw some light on the siting of hives.

> 9.1 'If a hive lay within the entrance to a house with its open end outside ...' [translator's note: The hive is here thought of as lying on its side, with its open end outwards, and partly inside and partly outside the house.]
>
> 9.2, 9.4, 9.6 'If the hive was raised one handbreadth above the ground ...'
>
> 9.3 '... When the hive is still a usable vessel and lies loosely [in the house entrance]. If it was wholly broken and stopped up with straw ...'

So a hive was breakable, and it might have another use; it could well have been a waterpot lying on its side. Figure 21.4a shows hives like this. A hive might be raised slightly above the ground, and it might 'lie loosely'.

Baba Bathra 5.3 referred to emasculating or castrating the bees – terms that were widely used to describe the prevention of colony reproduction (swarming) by destroying queen cells. In one version of the text castration was done 'with mustard', and in another it was supposed to result from the bees' consumption of excessive amounts of honey to alleviate the bitter taste of mustard. The swarming season might have occurred around the time of the nectar flow from mustard.

Later: 'If a man sold ... a bee hive he has sold the bees; ... if a man bought ... "the fruit of a bee hive", he may take only three swarms and [then the seller can] castrate it', i.e. prevent the issue of further swarms. This provision might have been necessitated by the large number of queens produced by a swarming colony of *Apis mellifera syriaca*. Removing them would prevent the issue of yet more afterswarms and the consequent depopulation of the colony.

21.2 Lands to the east: early records from Asia Minor

The first known evidence of hive beekeeping in Anatolia is in the Hittite law code written in cuneiform on clay tablets found among the archives at Bogazkoy, capital of the Hittite Kingdom. From its language and contents, the code was compiled at least as early as the 1500s BC. Figure 21.2a shows two paragraphs relating to the theft of bees and hives at that time and earlier.

> 91. If someone steals a swarm of bees, previously he paid 1 + [number missing] shekels of silver, but now he pays 5 shekels of silver, and the person wronged has the right to distrain on the house of the wrongdoer.

The fine for stealing a domestic animal was usually the restitution of six animals, so the 5 shekel fine meant that a swarm of bees was worth roughly a shekel – the same as a sheep.

> 92. If someone steals two or three beehives, previously he was exposed to the stings of bees, but now he pays 6 shekels of silver. If someone steals a beehive in which there are no bees, he pays 3 shekels of silver.

The mention of earlier penalties shows that hive beekeeping was not new. Since the hive could be stolen either with or without bees, it was a movable container, and had a value even if empty.

Figure 21.2a Lines 32-36 of the Hittite Law Code, 1500 BC or earlier, containing the earliest known beekeeping laws (Istanbul Archaeological Museum). See text for translation.

Paragraph 181 of the same law code stated that 'one tub of honey costs one shekel of silver'. The size of the tub is not known, but a shekel was also the price of a tub of butter, a sheep, or a swarm. (In Europe, prices of honey and butter were commonly about the same throughout the Middle Ages.)

Records after 334 BC, when the whole region except Arabia was under Greek influence, are mentioned in Section 23.13.

21.3 Lands to the east: early records from the Mediterranean coast and Middle East

Section 49.42 strongly suggests that lost-wax metal casting, using beeswax, was done in Judea between 3500 and 3000 BC, but we know nothing about the source of the beeswax.

Fife (1939) and several others quoted a sentence in the tale of an Egyptian hero Sinuhe (or Sanehat) as implying that honey was produced from hives in Palestine around 2500 BC. But the tale, from the 12th Egyptian Dynasty (c. 1991-1786 BC), described a vision of an idyllic country, not the geography of an actual one (Quirke, 1993). Around 1450 BC Tuthmosis III took much honey by capture and as tribute during his campaigns in lands that became Palestine and Syria: 470 jars were recorded in his 5th campaign, 'regular supplies' in the 7th, and 264 jars in the 14th (Forbes, 1966). But we do not know how the honey was obtained. Phoenicians who lived on the eastern Mediterranean coast exerted important influences throughout the Mediterranean region from about 1000 BC, and hive beekeeping is known to have existed in many areas with which they had contacts (Section 21.5)

Israelites settled in Canaan around 1200 BC, and were united into a kingdom under Saul before 1000 BC. Hebrew scriptures written probably between 800 and 100 BC contain many references to honey, but far fewer to bees or beeswax, and none to beekeeping or hives. One passage groups honey with agricultural produce, which suggests that the honey might have been produced in hives: after King Hezekiah (c. 700 BC) ordered the people living in Jerusalem, 'they gave generously from the firstfruits of their corn and new wine, oil and honey, and all the produce of their land; they brought a full tithe of everything' (II Chronicles 31.5, NEB)

Several well documented arguments for the existence of beekeeping in Palestine during Biblical times have been published (Bessler, 1886; Glock, 1891; Armbruster, 1932a; Fife, 1939; Neufeld, 1978), and some against it (e.g. Bodenheimer, 1934, 1951) and Thompson (1986). The earliest reference given by Ransome (1937) to hive beekeeping in Palestine was by Philo, a Greek philosopher born about 20 BC, who said that bees were kept by the sect of the Essenes who lived near the Dead Sea (*De vita contemp.* II, 663).

Neufeld (1978) discussed a jar from the 800s BC which was mistakenly identified as a hive; it was found in a tomb at Mount Tel-en-Nasbeh near Jerusalem, and had a 'spiral groove running round the domed side, which makes it look like a beehive made from coiled straw'. The jar was probably a water bottle designed to be hung (by a cord that passed along the groove) with its opening uppermost. Crane and Graham (1985) discussed some other mistaken identifications. A bronze relief on the gates of Shalmaneser III's palace in northern Syria, constructed between 859 and 824 BC, shows house roofs which were later described as beehive-shaped (because they looked like skeps used in northern Europe); this shape was an architectural form in the region, and was much used in decoration. See note on p. 183.

The book of medicines, written in Syriac between 323 and 284 BC, included remedies in which bees or hives were treated variously with wine, milk, children's urine, asses' dung, liver of a white falcon, and the eye of a bear; they are on pages 689, 702, 704 in the English translation by Budge (1913) and were quoted by Ransome (1937). These prescriptions show that hive beekeeping existed in Syria at that time, but little more. There are also a few references to hives in the Jerusalem *Talmud* written in the 300s AD.

The Arabian pensinsula and Islam

The honey bee in the region is *A. m. jemenitica*, which is highly adapted to life in hot arid regions. Several early reports of an abundance of honey in the mountains of southern Arabia are quoted in Section 7.3. Also Pliny (AD 23-79) mentioned 'the production of honey and wax' by the Sabaei there (VI.32.161), but we cannot be sure that hives were used.

Muhammad the Prophet lived from AD 570 to 632. The revelations he received were collected (in Arabic) in the *Koran*, and they mention bees and honey. The two relevant verses in Sura 16, entitled *The bee*, were translated by M.M. Rickthall as follows.

> 68. And thy Lord inspired the bee, saying: Choose thou habitations in the hills and in the trees and in that which they thatch;

about 3100 BC, bees must have been kept in hives well before that time – from perhaps 5000 BC.

It is still not known where the Ancient Egyptian type of beekeeping first started, whether in Egypt or elsewhere. Section 20.2 comments on the lack of bee-friendly areas in Mesopotamia. Baumgartel (1975) associated *bit* with the Naqada II people and the country between Egypt and the Red Sea from which they came, but her views are not universally accepted. In any case the Naqada climate – and in the area farther east – would be hot and arid, and unlikely for the initiation of hive beekeeping. Section 28.8 refers to a suggestion that the hives in Ancient Egypt followed the style of log hives used farther south, but I regard this as very unlikely.

The region in Egypt where bees might be expected to flourish was the Nile delta, with its more plentiful water supply and a Mediterranean climate. From the environmental point of view, consideration might be given to the idea of an initiation of hive beekeeping in the delta during the Predynastic period, and its development and spread after the two Kingdoms were united.

69. Then eat of all fruits, and follow the ways of thy Lord, made smooth (for thee). There cometh forth from their bellies a drink diverse of hues, wherein is healing for mankind. Lo! herein is indeed a portent for people who reflect.

Some authorities translate the end of verse 68: 'and of those materials wherewith men build hives for thee', but the text does not provide certain evidence for the use of hives.

Hives were specifically mentioned by al-Baladhuri, of Persian origin, who died in 892. His book on the origins of the Islamic State (see Hitti, 1966) related to the region of At-Ta'if, a walled city 50 km south-west of Mecca. In a passage on almsgiving, al-Baladhuri quoted one authority as saying 'there is *sadakah* [voluntary almsgiving] on the bee-hives', and others 'there is no *sadakah* on hives'. However, a manuscript *The book of the bee* written about AD 1222 had nothing to do with bees: the author, Soloman, Nestorian Bishop at al-Basra, explained that he collected material for it as a bee collects its food. The book was edited, with an English translation, by Budge (Oxford: Clarendon Press, 1886).

According to the historian Ma'wali who wrote between 1750 and 1800, hive beekeeping was introduced to Oman at some time after 1624.

21.4 Lands to the east: recent traditional hive beekeeping

21.41 Hives, and general practices

Traditional beekeeping with horizontal hives still survives in all countries of the region, and Table 21.4A indicates the types of hive in each. The text and Table follow the order in the list below, and are based on the publications cited; those marked * are detailed studies and some give dimensions of hives.

Israel (Canaan/Palestine): Buttel-Reepen (1921); Armbruster (1957); Karlsson (1970)
Jordan: *Robinson (1981)
Lebanon: Buchanan (1946); Yazbek (1989); El-Hage (1991)
Syria: Buchanan (1946)
Turkey: *Bodenheimer (1942)
Iraq: *El-Naga and Hagezi (1983)
Iran: *Komeili (1990)
Arabian peninsula: *Karpowicz (1989); *El-Sarrag (1989)

Table 21.4A

Types of traditional hive still in use in the 1900s in countries to the east of the Mediterranean

E Egypt — *L* Lebanon — *Q* Iraq (Mesopotamia)
I Israel — *S* Syria — *R* Iran (Persia)
J Jordan — *T* Turkey (Asia Minor) — *A* Arabian peninsula

The first six countries have a Mediterranean coastline.
x = record of use. References are listed in the text.

Hive type (all used horizontally)	*E*	*I*	*J*	*L*	*S*	*T*	*Q*	*R*	*A*
Earth materials									
cylinder of sun-dried mud[1]	x	x	x	—	x	x	x	x	x
cylinder of fired clay[2]	x	x	x^4	x	x	—	x^5	x	x^5
cylinder of fired clay, flared	—	—	—	—	x	—	—	x	—
sun-dried mud[1], conical with pointed front	—	x	—	—	x	x	x	x	x
conical, fired clay	—	x	—	x	x	x	—	x	—
pot-shaped, fired clay	—	x	x	x	—	x	x	$x^{4,5}$	x^5
Plant materials									
log	—	x	—	x	—	x	x	x	x
woven cylinder[3]	—	—	—	x	x	x	x	x	x
woven[3], conical and/or with pointed front	—	x^4	—	—	x	—	x^5	$x^{4,5}$	—
wooden boards	—	—	—	x	—	x	x	x	x
Honey extension used with some hives	—	—	—	x	—	x	x	x	x

[1] The mud may be mixed with chopped straw.
[2] Pottery, earthenware.
[3] Woven hives are usually coated with mud/dung.
[4] In bee house.
[5] In house or other wall.

Similarities to Egyptian beekeeping are apparent throughout the region, but the variety of hives was much greater than in Egypt. In dry areas earth materials were used, and where rainfall was higher hives were constructed from bound or woven plant materials or, in forested areas, from hollow logs or (nowadays) wooden boards. Such hives are not breakable like those of mud or clay, and many are lighter in weight and easier to transport.

All hives were opened at the back to harvest honey combs. Some were rather similar in shape to those used recently in Egypt (Section 20.5), but there was a wide variety: cylindrical, rectangular or conical, or like a water pot or other domestic vessel (Figure 21.4a). In addition, some hives in parts of the Arabian peninsula and Lebanon, also Turkey, Iraq and Iran (formerly Anatolia, Mesopotamia and Persia) were improved in a way not known in Egypt: an extension was added to the hive for honey storage during the main flow (Section 38.21).

Buttel-Reepen (1921) collected reports on Palestine made by P. Baldensperger and others during the

Figure 21.4a Pots in the base of which an entrance hole has been made, embedded in a wall and used as primitive hives (photographer unknown).

1890s and early 1900s. In the mountains, hives were long narrow cylinders of earth and dung, dried in the sun. Colonies were not commonly fed, but a shallow open dish of syrup, or dates (whole or mashed with water) might be inserted in the back of a hive. In Israel in 1996 I saw various hives used by Arab beekeepers. Cylinders of mud and straw varied in length from 52 to 86 cm, and the external diameter from 22 to 30 cm. The flight entrance was in the closed end or in a closure at an open end. Combs had been built in any direction. The only hives I saw in use were in Arraba in Galilee. I also saw empty cylindrical pottery hives from Gaza – in Galilee, Samaria and Judea – all fairly similar, 52-58 cm long and 24-28 cm in diameter.

'Clay' hives in Jordan measured by Brother Adam (1954) were 66 cm long, with walls 5 cm thick and a 30-cm internal diameter. In Lebanon, one beekeeper had up to 30 horizontal conical hives 70-80 cm long (El-Hage, 1991). Alternatives were a woven cylinder coated with mud and cow dung, and a hive of wooden boards 150 cm long which was said to be the best for transport; two were laid along each side of a mule's back, one above the other (Yazbek, 1989). A large part of Syria is desert, and many of the hives were of earth materials.

In Turkey, I found most of the listed hives in use in 1985, some with extensions. In wooded areas, especially in the mountains, there were log hives closed with stone discs. I also saw hives of wooden boards. In the treeless Anatolian plain, cylindrical hives were woven from grape vines, or made of earth materials. In addition, near Bursa just south of the Sea of Marmora large numbers of skeps (Figure 21.4b) were made and used by beekeepers from Bulgaria who had migrated there.

In Iraq most traditional beekeeping was in the mountains in the north, near the borders with Persia and Turkey, especially in Suleimaniya and Amara provinces, at about 36°N. A detailed study by El-Naga and Hegazi (1983) showed that ten different hives made of plant materials were used in these mountains, almost all cylindrical or conical in shape. Bees for use in modern hives in the arid parts of Iraq farther south were obtained from the same region.

Much traditional beekeeping in Persia (Iran from 1979) was concentrated in the mountainous provinces of Luristan, Kermanshah and Kurdistan, adjacent to Iraq, and all types of hive entered in Table 21.4A under Iran and Iraq were used there. The following horizontal hives in Iran were described and illustrated by Komeili (1990):

- pottery hives in Kurdistan (water pots, with an extension), Kermanshah and Hamadan, and mud cylinders in Luristan;

Figure 21.4b Hives made by a Bulgarian beekeeper near Bursa, Turkey 1985 (photo: E. Crane). Horizontal log hives, frame hives (below), and Bulgarian-type skeps.

- woven cylinders in Luristan and Azerbaijan, and other woven hives in Kurdistan;
- log hives in northern Iran.

Cylindrical hives were embedded in house walls (Section 32.21), especially in very hot dry lands where this afforded some protection against high temperatures and diurnal temperature changes.

In the Persepolis area of Farsistan farther south, cylindrical pottery hives had an inset front cover integral with the rest of the hive, glazed and ornamented in bas-relief (Mossadegh, 1993).

Round Tabriz in Azerbaijan, Meshed in Khorassam, and elsewhere in northern Persia, an ornamented disc of glazed pottery was added on the front of a woven cylindrical hive, with an entrance hole pierced through it. This was developed into an art-form, painted in a richly coloured decorative design before firing. Figure 21.4c shows a hive with the cover in place, and Figure 21.4d a stack of similar hives without the covers. Two Dutch museums have collections of hive covers. They are no longer used in Iran, but between 1968 and 1979 Dr A. Middelhoek collected a hundred of them which were sold in 1993, and Sotheby's catalogue included individual photographs and descriptions. Dates inscribed were between 1735 and 1935, and the following motifs were the most common: mammals or unidentifiable animals; then geometrical or other patterns; birds; people (mostly men); inscriptions from the *Koran* or elsewhere. No. 73, reproduced in Figure 21.4e, shows a man in pantaloons who seems to be opening the back of a conical hive supported by a forked stick.

Figure 21.4d Stack of empty hives like that in Figure 21.4c, before being coated with clay and the pottery front inserted (photo: A. Middelhoek). In view are 6 front hive ends with an inset woven closure, and 12 open back ends, some showing weaving stakes. Flight entrances are not apparent, and perhaps not yet made.

Figure 21.4c Woven hive coated with clay, showing the glazed pottery front cover, late 1800s, Meshed, Iran (Copyright, Trustees of the British Museum). Length 85 cm, diameter 31 cm. The Persian inscription reads:

Oh the One who judges needs
Oh the One who requites tasks
Oh the One who averts misfortunes.

Figure 21.4e Persian beekeeper with a conical hive, depicted on an undated pottery hive front used as in Figure 21.4c, Meshed, Iran (Copyright, Trustees of the British Museum). The man appears to be ready to take honey combs from the back of the hive, whose flight entrance at the pointed front end is reinforced, like the front end of the hive in Figure 21.4g.

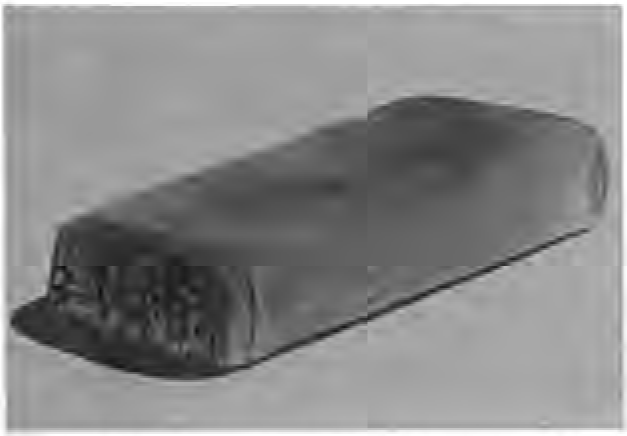


Figure 21.4f Wooden hive from the Radfan mountains of Arabia, 116 x 45 x 19 cm internally, 1960s (IBRA Collection B68/16).

In the Arabian peninsula there were also many different hives, of both earth and plant materials. Karpowicz (1989) gave detailed descriptions of wooden hives in North Yemen in the south-west. Almost rectangular hives with rounded edges (Figure 21.4f) were characteristic, with end closures rebated internally and usually ornamented externally, and two or three round flight entrances pierced through the front one. Log hives, up to 160 cm long, were also used. In 1915, honey from the Yeshbum valley in Yemen was exported all over south Arabia, and as far as Zanzibar and northern India (Bodenheimer, 1951).

In some parts of Arabia, bees could not survive in wooden hives unless these had extra protection against the heat (Al-Ghamdi, 1990). Hives were embedded in house walls (Ingrams, 1942), and in high mountain areas where the rock was schist, artificial caves were made by alternately heating and cooling the rock with water so that it split off in sheets like slate. Caves usually faced south, and were made large enough to accommodate several hives and a working space behind. The length of the hives was sufficient to prevent the beekeeper reaching (and removing) the front few combs when he took his harvest through the back opening. Local peoples owned the mountains, but beekeeping was a hereditary occupation of certain families, and each cave was the heritable property of the family that made it.

Even recently people in Wadi Du'an, in Hadhramaut east of Aden, did not believe that the 'father' in the hive was a female queen. 'It is the leader, and whoever heard of a woman leading an army like that? ... The bee women [drones] are bigger and don't sting' (Ingrams, 1942). A beekeeper searched for the 'father' in a swarm, and 'tied it up with cotton to a piece of wood, or else a little cage of matches and cardboard is built round her' (Paxton, 1966). The front of the hive was like the top of a water pot, and combs were harvested from the back. Hives were usually placed in groups and were well insulated against the heat. They were migrated to different flows, and much honey was produced in spite of the lack of modern knowledge and techniques (but see end of Section 21.43); up to 500 camel loads were sent each year from Wadi Du'an to the coast.

21.42 Conical hives, and their use in bee houses

Conical hives with the flight entrance at the pointed front (Table 21.4A) were made of earth materials in dry areas, and woven from plant stems elsewhere: Lebanon, Turkey, Arabia (earth); Israel, Syria, Iraq, Iran (both). Figure 21.4e shows a Persian beekeeper standing at the back of a conical hive, and Figure 21.4g is a drawing of a conical mud hive from Iraq. These hives were often embedded in a wall (Section 32.21), or kept in an enclosed bee house (Section 32.32) or dwelling house, with the tip pushed through the wall and cemented to it. They provided a small space at the tip where a new swarm could start building, and a beekeeper could easily harvest (large) honey combs by removing the back closure. Hives in a bee house, or embedded in a wall, were protected against heat, and against human and animal marauders.

Buchanan (1946) described a similar hive as standard in one part of Syria; it was a cone closely woven from reed and palm leaves, about 120 cm long and 50 cm in diameter at the back, 'heavily coated with clay and dried'. The hives were kept in a bee house, with the pointed entrance end projecting 8-10 cm beyond the south wall.

On the plains of Palestine, conical hives were made of fired clay, 50-70 cm long and tapered from

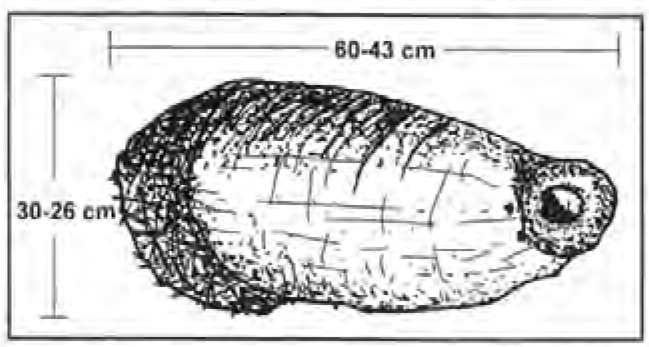


Figure 21.4g Traditional conical hive of mud, widely used in northern Iraq (drawing: A.M. Abou El-Naga).

Table 21.4B

Some Indo-European names for combs built across or along a horizontal cylindrical hive, and for the bees that build them

Region	*Across the hive*		*Along the hive*	
	Name	*Meaning*	*Name*	*Meaning*
Lower Egypt	*helali*	full moon	*herati*	ploughed furrow
Jordan	*kamari*	full moon	*hanthi*	ploughed furrow
			sayafi	sword
Lebanon	*hilali*	full moon	*harrati*	ploughed furrow
				(considered more aggressive)
Turkey	*kiliç*	armour	*kalkan*	arrow
Iran (Persia)	*nani*	loaf of bread	*shamshiri*	sword
	ghorsi	full moon		
Cyclades, Greece	*chleni*	warm way	*orthoris*	cold way, sword-like
Cyprus	*koskinas*	(*koskin* = round chaff cutter)	*oxides*	(considered more aggressive)
Kashmir, India	*soache*	round (loaf of bread)	*dare*	straight
Nepal	*juwa*	yoke of ox-cart	*harish*	shaft of ox-cart

the back (25-30 cm across) almost to a point at the entrance end, 'like a sugar loaf' (Buttel-Reepen, 1921). They were in rows of 10 to 15, apparently stacked in 5 or 6 tiers. A branch might be placed in contact with the entrance hole as a sort of alighting board for the bees, but there was no hive management, no feeding of colonies, and hives were not migrated.

Manipulations for dividing colonies and fixing combs across an empty hive (Section 20.5) were impracticable with conical hives, and they could not be opened from the front.

21.43 Beekeeping operations to regulate the direction of comb building

The direction in which the bees built their combs in a horizontal hive was important to the beekeeper. Combs built across a hive could easily be harvested complete, and they were used in Egypt to make new colonies (end of Section 20.5). Combs built along a hive would almost certainly be broken in harvesting, and a number would contain brood. Many beekeepers in the eastern Mediterranean region believed that the two types of comb were built by different bees*, and Table 21.4B lists the two terms used for the bees or their combs in some regions discussed in this Chapter and elsewhere. Usually (round) combs built across the hive were designated by the shape of the moon or domestic or agricultural objects, and combs along the hive by agricultural or military terms.

In 1790 della Rocca (in Syros, in the Aegean) devoted Chapter 2 of his Volume III to the direction in which bees built combs: across or along the hive, or in an intermediate direction. The first was the most convenient for the beekeeper, and was ensured by fixing a few combs in an empty hive using a forked stick: 'Cette fourche est la même dont font usage, dans l'île de Syra, tous ceux qui élèvent des abeilles' (Vol. II, p. 488).

The following recent examples almost certainly represent a continuation of practices from earlier times. Bikos (1994d) found that, in some of the islands where horizontal pottery hives opening only at the front were still used, bees built combs across 60-70% of the hives. Beekeepers regarded this as normal, and if bees built combs along a hive or at an intermediate angle, the situation was remedied after harvesting combs (from the front part of the hive). A single comb was fixed *across* the hive, adjacent to the combs remaining, and as a result the bees continued building combs across the front part of the hive and then across any extension added later.

Traditional beekeepers in several parts of the south of the Arabian peninsula knew how to get their bees to build combs across their hives. Paxton (1996) said that in Dhala in the Radfan Mountains, inland from Aden: 'in the centre of the hive, three dry pieces of comb sprinkled with honey are suspended and supported with twigs.' In North Yemen, hives without bees set out by beekeepers to attract swarms 'contain 2 or 3 pieces of comb propped upright by thin sticks wedged against the walls in an X shape; the

*This is not true, and Brother Adam (1954) suggested how the idea might have arisen: a large prime swarm which has great wax-producing ability might build combs lengthways, whereas a small swarm or an afterswarm might build a few combs across the hive near the entrance, which it could defend against wax moths. In many countries the bees that built combs along the hive were thought to produce more honey, and also to be more aggressive; perhaps harvesting honey disturbed such colonies more.

swarm will build new comb on either side of the inserted pieces, expanding the nest forward and backward' (Karpowicz, 1989). Hansen (1995) published recent photographs of both packaged round combs and horizontal cylindrical earthenware hives in Wadi Du'an, so beekeepers there were also able to get combs built across their hives. In the mountains of Oman inland from the Gulf coast (Wadi Ben Auf in Jebel Akhdar), combs were built across horizontal hives of fibrous logs of the date palm (Johnston, 1997). When making a new colony, a beekeeper removed a (round) comb from a populated hive, and fixed it across an empty hive. This was done by pushing the two ends of a stick into the interior hive wall, pressing the comb against it, and securing this with a second stick similarly fixed across the hive. When bees (and queen) were put into the hive, they built new combs parallel to the guide comb, across the hive. In Sicily, rods were inserted in a *Ferula* hive to fix combs across it (Section 22.13).

In Iran across the Gulf of Oman, Mossadegh (1993) found that traditional beekeepers preferred colonies to build combs across the hive, and in the past had followed several procedures to encourage this. About 60% of the colonies still did so, although the beekeepers' knowledge of traditional methods was dying out.

Section 38.22 discusses ways in which the hive itself was treated to improve comb attachments to it, or to control their direction.

21.5 Lands to the south: early records

Carthage and the Phoenicians

The homeland of the Phoenicians was on the eastern Mediterranean coast, roughly where Lebanon is now; their civilization lasted from about 1500 to 300 BC, and they were at the height of their power between 1000 and 700 BC. Phoenicians were traders who sailed throughout the Mediterranean, and were pre-eminent masters of the sea. They traded with Egypt during the New Kingdom when hive beekeeping was portrayed in detail (Figure 20.3b), and also with Mesopotamia. Between 800 and 300 BC they controlled much of the North African coast and the south and east of Spain, also Malta, Sardinia, Corsica, the Balearic Islands and western Sicily; they established many way-stations and settlements. Beekeeping flourished in Antiquity in many of these areas, but no details are known of actions by Phoenicians in disseminating it, except the great work on agriculture – including beekeeping – written in Phoenician by Mago who lived in Carthage in North Africa some time between 250 and 150 BC; Carthage (opposite Sicily) was the most important Phoenician colony, founded according to tradition in 814 BC.

Mago's own beekeeping experience would probably have been in North Africa, and he may have used earlier literary sources now lost. Cassius Dionysius of Utica translated 20 of his 28 books into Greek. Beekeeping was probably well established in North Africa by 256 BC when the Romans first landed there. After they destroyed Carthage in 146 BC Mago's books were taken to Rome, and were translated into Latin by order of the Senate. Mago's original books and their Greek and Latin translations have all been lost, but the Latin translation was quoted by the Roman authors whose books postdate it: Varro, Virgil, Columella and Pliny (Section 24.1). Mago was honoured by Columella as the father of agriculture, and his texts may well have been the starting point for Ancient Roman writings on beekeeping and thus for later beekeeping books in much of Europe. Mahaffy (1875) summarized what is known about Mago's life and work.

In Roman times Carthage was renowned for the quality of its honey, and for beeswax known as Punic wax (Section 49.51).

Rest of the North African coast

Few beekeeping records have been found relating to other parts of North Africa west of Egypt. The earliest likely one concerns Libya which adjoins Egypt. Herodotus (485-425 BC) wrote: 'Next to the Maxyes of Libya are the Zaueces, whose women act as their drivers when they take their chariots into war. Next to these are the Gyzantes, a people where their bees produce a great deal of honey, but, it is said, craftsmen make much more' (IV.193-4). Perhaps 'their bees' were in hives, and the craftsmen made a sweet 'honey' from dates or other fruit; Herodotus said later (VII.31) that men in Lydia in Asia Minor 'make honey out of the fruit of the tamarisk'.

An inscription in Tunisia dated to AD 115-117 laid down the dues to be paid by tenants on the produce of their holdings. Flach (1978) gave the following most likely interpretation of the rather incomplete text. A beekeeper with 1 to 5 hives paid 1 pint of honey per hive, and a beekeeper with more than 5 paid one-fifth of the honey present at harvest time – which would normally be more than a pint per hive. In the 1300s a Tunisian text, the *Muqaddimah*, said that some people made a living by 'the use of sheep, cattle, goats, bees and silkworms, for breeding and for their products'.

Where the cork oak (*Quercus suber*) grew – now from Tunisia westward – hives were made of bark cut from the tree and allowed to resume its natural shape, as in Figure 21.6a. Varro liked these hives most, contrasting them with earthenware hives that 'are most severely affected by cold in winter and by heat in summer' (*De re rustica* III.16.17). Beekeepers in parts of North Africa used *Ferula* hives, with or without the special system known in Sicily (Section 22.13). Roman writers mentioned these hives, but did not describe them or how they were used; perhaps Mago had written about them.

Section 46.82 indicates the importance of beeswax exports from Morocco during and after the 1500s. Seyffert (1930) quoted many references to honey in Morocco from the 1600s onwards – of choice quality, or bright yellow, or candied like snow – and to ways in which it was eaten: with cakes or bread or in meat dishes, and in a preserve made with meal and butter, used as a sustainer during long journeys.

21.6 Lands to the south: recent traditional hive beekeeping

The following authors described traditional beekeeping and hives in the 1900s.

North Africa, general: Lefébure (1905); Baldensperger (1921); Alber (1953); Secord (1974/75)
Libya: Brittan (1955/56)
Tunisia: Vallette (1922); Paradeau (1951); Hicheri (1984); Bacher (1995)
Algeria: Vallette (1922); Paradeau (1951); Griessinger (1956/57)
Morocco: Vallette (1922); Haccour (1961).

Almost all traditional hives in North Africa were horizontal cylinders that could be opened at either end, as in Egypt. Griessinger (1956/57) mentioned conical (presumably clay) hives in Algeria, 30 cm across at the wide end. Hives were also made from cork, or woven from plant stems available locally, and rectangular hives were made from stems of the giant fennel (*Ferula communis*); see Section 22.13. There was probably no need to make hives of logs or of sun-dried mud, but fired clay was used to some extent.

Libyan beekeepers in Cyrenaica used forked sticks to support combs. Brittan (1955/56) explained that they collected swarms:

> which they have learnt to put into heavy wooden boxes, long, wide and shallow (60 x 25 cm), capable of holding 15 combs. Two or three forked juniper sticks are jammed as pillars from floor to roof in the centre or towards the front of the box to support the heavy brood combs. ... It is said these boxes were in use more than 200 years ago, even before the Turkish era. Honey is cut out from the back and front entrances.

A photograph shows combs built diagonally across one of the hives, and it seems possible that the forked sticks 'to support the heavy brood combs' were derived from the smaller twigs used in Egypt to fix individual combs across an empty hive, but that the memory of this function has been lost.

In Tunisia hives were horizontal cylinders of cork, clay or woven grass or wicker, in which 'bees built combs according to their instinct' (Hicheri, 1984), or 'parallel to the end-closure' (Bacher, 1995). Hives were laid on the ground, and woven ones were well insulated with a thick layer of dried grass; they might be in three tiers, with esparto grass stuffed between. After harvesting honey combs from one end, the hive might be turned round end-for-end, so that the bees would build new combs at the end now empty, and rear brood there (Bacher, 1995). With *Ferula* hives in Sicily (Section 22.13), a different operation achieved a similar result.

Published photographs of round combs from both Tunisia and Algeria suggest that some beekeepers may have been able to fix initial combs across a hive. In a study of earlier records, Lefébure (1905) referred to the use of horizontal hives of *Ferula* stems by the Kabyle (a Berber people in the mountains of eastern Algeria) and elsewhere in Algeria, and also hives of cork and of woven plant stems, as in Tunisia. Hives were populated by collecting swarms directly in them. In 1987, a quarter of the 200,000 hives in Algeria were still traditional ones. They were about 100 cm long and 20 cm in diameter, and were placed in a row on the ground or a platform of stones, and protected from the sun by a layer of alfa (esparto grass, *Stipa tenacissima*).

Figure 21.6a shows horizontal hives in Morocco, including (on the left) one of wooden boards. Cylindrical pottery hives were also used, with a long extension for honey storage (Figure 38.2b), or two hives were placed mouth-to-mouth. In 1986 there were 1400 beekeepers in the High Atlas, with 16,000 traditional hives (El Hassania & Campi, 1995).

Figure 21.6a Cork cut from a tree to make a hive, lying between a woven and a pottery hive, Morocco, 1964 (photo: E. Crane). According to Virgil (*Georgics* IV.33), the edges of the cork would be sewn together.

21.7 Lands to the west: ancient hives excavated in Spain

Until recently nothing was known about hives in Spain before the Roman period, but in 1995 Bonet and Mata were able to identify as hives a number of pottery vessels or fragments of them excavated in the Valencia region. They came from 78 sites – mostly in an area about 18 x 18 km – inland from Saguntum and Valencia in the drier eastern part of Spain with an annual rainfall of 250-500 mm. In all, 122 hives were identified; 46 were dated to 250-175 BC in the Iberian period, 51 when the east of Spain was part of the Roman Republic (175-27 BC), and 25 when it was a province of the early Roman Empire (27 BC to AD *c.* 250).

Figure 21.7a shows a photograph of five of the

Figure 21.7a Horizontal pottery hives from the Iberian period (250-175 BC) excavated in the Valencia region, in Museo de Prehistoria de Valencia, Spain (Bonet & Mata, 1995).

pre-Roman hives, Figure 21.7b drawings of these and another similar hive. All the hives found had shallow incisions on the inner surface; these would enable the bees to attach their combs securely; see Section 23.21. Dimensions (cm) of hives shown are:

		Length	End diameters
2585	Tossal de St Miquel, Llíria (site 27)	59	27.5, 26
4950	La Monravana, Llíria (14)	55.5	28, 26
7511	Puntal dels Llops, Olocau (16)	57.2	27.7, 29.5
7512	" " "	53.8	25, 24
7513	" " "	58	26.5, 26.5
7514	" " "	54.5	29, 29

It is likely that the excavated hives were used in the way described later by Roman writers (Section 24.1), some of whom would almost certainly have seen such hives. The hives could have been introduced to eastern Spain by Carthaginians, who captured a settlement they named Carthago Nova, south of Saguntum, in 223 BC.

I saw similar hives in the late 1900s in the Ebro valley, where they were normally embedded in (across) a wall; see Section 25.6 and Figure 32.2a.

Hives for honey bees contemporary with the Spanish ones were found in Greece, where hive closures and extensions were also excavated (Section 23.2), neither of which have been identified in Spain.

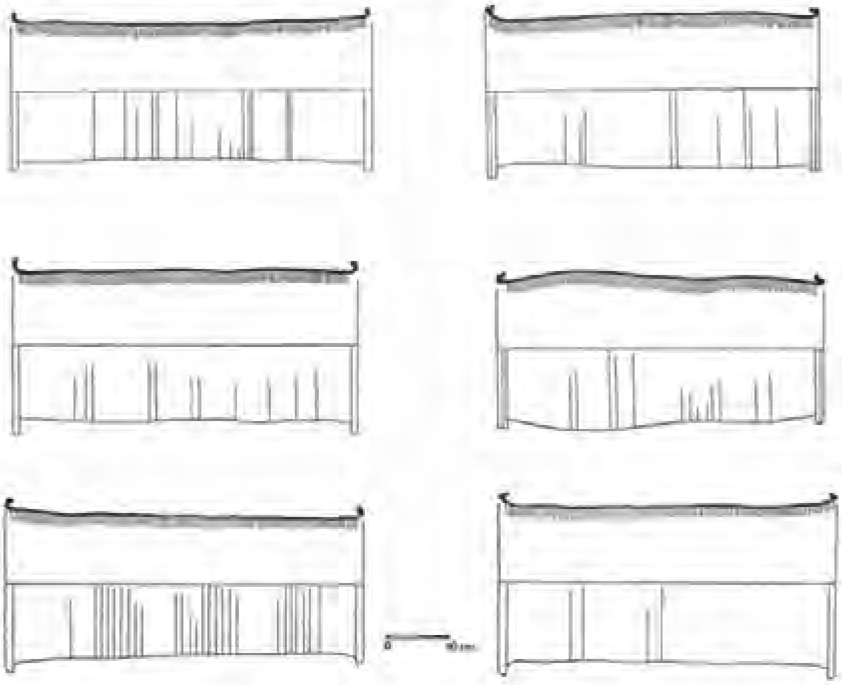


Figure 21.7b Hives in Figure 21.7a and one other, drawn to indicate shallow incisions on the interior (Bonet & Mata, 1995). Catalogue numbers: *top* 2585, 4950; *centre* 7511, 7512; *bottom* 7513, 7514

21.8 Differences and common features in the three regions

Judging from hives whose shape and orientation we know, in all the regions and from Antiquity to the present day, the bees flew out at one end of a horizontal hive, and the beekeeper harvested honey from the other end – or in a few examples from the same end. The total capacity (volume) required for a hive was governed by the size to which the bees extended their nest in summer, and this was smaller for many Mediterranean honey bees than for the bees of continental Europe. Woven hives and hives of mud were somewhat narrower (and longer) than those of pottery or wood. I think the hive diameter was restricted by what was possible with the materials of which the hive was made, and there may have been an upper limit in that large (deep) combs would be liable to break during harvesting. Pottery hives measured recently from Gaza (in the east) had a diameter and length very similar to those of excavated hives made in Spain between 250 BC and AD 250. The many common features of the hives and their usage point to a common origin, which I think was the beekeeping of Egypt from c. 2400 BC or earlier.

It is likely that hives were made of plant materials where these were available; such hives were unbreakable, lighter and more convenient than those of earth materials, and more bee-friendly, giving better thermal insulation. But hives of earth materials were also successful – and only these survive from the distant past.

One significant difference between beekeeping in North Africa and the other Mediterranean lands was the unimportance of bears in Africa (Section 5.2). In some parts of the other regions, beekeeping could be done only if hives were made secure from the brown bear, *Ursus arctos* (Sections 32.2 and 32.53).

Note added in proof

Much evidence has been presented which shows that horizontal hives were used in the Ancient Mediterranean region and east of it; upright hives were introduced later from parts of Europe north of the Alps (Chapter 25).

Professor A.J. Graham has drawn my attention to a possible early representation of an upright hive in Jordan. In *The Mosaics of Jordan* (Amman: American Center of Oriental Research, 1993), M. Piccirillo published a colour reproduction of a beautiful mosaic at Madaba just east of the Dead Sea, dated to AD 500-550. Near the foot, a Cupid is putting his head into an overturned yellow skep-shaped container, and many bees are flying around. In a contribution to Piccirillo's *I mosaici di Giordania* (Rome: Quasar, 1986, pp. 117-127), H. Buschhausen (1986) related the scene to *Idyll* XIX of Theocritus (310-250 BC) in which bees stung Cupid when he stole honey from their hive.

22

Traditional Hive Beekeeping in Mediterranean Islands

22.1 Major islands except Crete

22.11 Introduction

Seaways between the Mediterranean coasts and islands were travelled from very early times. Many of the islands where hive beekeeping flourished in Antiquity had Phoenician settlements: Cyprus, Sicily, Malta, Sardinia, the Balearic Islands, and eastern and southern Crete. It seems very likely that the Phoenicians played an important part in disseminating knowledge about beekeeping, in the course of their trading and other activities between about 1500 and 300 BC (Section 21.5), but no direct link has been found.

Traditional beekeeping still survives, and Table 22.1A summarizes the types of hive used in the 1900s, almost all of them horizontal; conical and pot-shaped hives (Table 21.4A) were not found. Islands in Section 22.1 are dealt with in order from east to west, and Crete and Aegean islands are in Sections 22.2 and 22.3.

Table 22.1A.
Types of traditional hive still in use in the 1900s in major islands of the Mediterranean

Cp	Cyprus	*Co*	Corsica
Si	Sicily	*B*	Balearic Islands
Rh	Rhodes	*Cr*	Crete
M	Maltese Islands	*R*	described by Roman writers
Sa	Sardinia		

Hives described by Roman writers were used in Roman lands, but not necesarily in Italy.

Conical hives and fired pot-shaped hives (Table 21.4A) are absent.

For islands in and around the Aegean, see Section 22.3.

Hive type (most used horizontally)	*Cp*	*Si*	*Rh*	*M*	*Sa*	*Co*	*B*	*Cr*	*R*
Earth materials									
sun-dried mud cylinder	x[1]								
fired clay cylinder	x[2]						x[1]		x
fired clay cylinder, flared	x							x	
fired clay, bottle-shaped				x[1]					
bees hived direct in wall cavity	x								
Plant materials									
hollowed log			x			x			x
cork bark						x			x
cork bark (upright)					x				
woven cylinder							x[1]		x
Ferula stems		x							x
wooden boards		x				x			x
Honey extension used with some hives				x					

[1]in bee house or cave; [2]embedded in wall.

22.12 Cyprus

Cyprus had contacts with both Egypt and Syria during the Late Bronze Age (1600-1050 BC) and was occupied by Egypt around 1400 BC. Hive beekeeping might have been introduced during this period, but the earliest known reference to bees is a statement by Herodotus in the 400s BC that a swarm had occupied a skull hung in front of the temple of Aphrodite (Adam, 1954). Some five hundred years later Cyprus was noted for the quantity of honey it produced (Pliny, XI.14.33).

During excavations at an Early Byzantine pottery factory at Dhiorios, used between about AD 650 and 750, Catling (1972) found part of two roughly cylindrical vessels, P333 and P255, whose maximum diameters were 34 and 38 cm; one of the parts found was 22.5 cm high (long), and the other less. Both had 'extremely sharp and close-set wheel ridging on the inside'. P333 had been 'ridged by a comb-like tool with close-set teeth', and P255 'either finger- or spatula-ridged'. Dr Catling believed that the ridging of both vessels must have been functional, and suggested that foodstuffs might have been rubbed over the roughened surface to grate them. After the publication of hives excavated in Greece (Section 23.21), Dr Catling suggested to me that the finds in Cyprus were also parts of hives or hive extensions, and I agree.

An entry for 1483 in *Excerpta Cypria* (Cobham, 1908) described the hiving of bees into wall recesses (Section 16.5), and entries for 1484, 1571, 1609-1621 and 1700 referred to honey – some to an abundance

Figure 22.1a Shelter containing a wall with 16 hives of mud and chopped straw embedded in it, flanked by two 'modern' hives, Cyprus, c. 1920 (photo: G.H. Hewison).

Figure 22.1b Protected stack of hives, Cyprus, 1992 (photo: I. Shaw). The round front of each hive looks light where the stone hive closure is in place, or dark where it is missing.

of it. The first reference to hive beekeeping dates from 1801. 'In the cottages of Attien they build up a wall formed entirely of earthen cylinders each about 3 feet in length placed one above the other horizontally, and close their extremities with mortar. This wall is then covered with a shed, and upwards of 100 swarms may thus be maintained within a very small compass.'

The traditional hive now found in Cyprus (*jivardi*) is a slightly flared horizontal cylinder of fired clay 60 to 70 cm long, with an external diameter of 25 to 28 cm at the front where the flight entrance is, and 28 to 32 cm at the wider back where the hive is opened to harvest honey combs (Zyngas, 1991). The ends are closed with discs of stone, or less commonly wood, sealed on with mud. Cylinders (not flared) of sun-

dried mud mixed with straw are also used as hives; their walls (4-5 cm) are thicker than those of the flared pottery hives (2.5-3.5 cm). Hives are still stacked as they were in 1801, and are usually cemented together into what can look like an isolated length of wall; or they may be sheltered by a roof insulated with a layer of dried vegetation. Three tiers are usual, but there may be up to 6, or only one. Figure 22.1a shows a small three-tier shelter, and Figure 22.1b a longer stack of hives protected by roof tiles.

In common with beekeepers in mainland regions to the east, those in Cyprus believed that different bees built combs across and along the hive (Table 21.4B), and it seems unlikely that they could ensure that bees built their combs across their hives.

In 1894 there were about 520,000 traditional hives, but by 1946 the number had dropped to 23,000, and by 1990 to 1000; the island then had 38,000 movable-frame hives.

22.13 Sicily

Sicily, especially Hybla in the north, was much praised for its honey during Antiquity, and Columella quoted Celsus as saying that hives 'are moved from the other parts of the island to Hybla' (IX.14.19).

The important traditional hive (Figure 22.1c), used for a special system of beekeeping, was a long rectangular box made from dried stalks of giant fennel* cut into equal lengths (from the 1800s, 21-24 cm). Several Roman authors mentioned *Ferula* hives: 'Some make [hives] from the fennel plant, making them rectangular, about three feet long and one foot across' (Varro, III.16.15); 'good vessels for bee hives can be constructed out of [fennel stalks], because they have similar natural properties to cork' (Columella, IX.6.1). These writers did not say where or how the hives were used, and may not have known.

Ferula hives in Sicily were probably used in Antiquity in the same way as in recent times, and a similar system perhaps also existed in part of North Africa. Alber (1953) referred to the ancient craft of

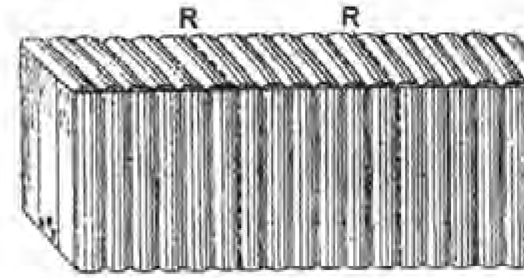


Figure 22.1c Engraving of a *Ferula* hive from Favignana, Sicily (Buzairies, 1863). Two or three upright rods were pushed in at R, R. The centre section between them was the brood nest, and honey combs were harvested only beyond the rods.

the Arabs being 'forgotten' in most Arab countries [in north Africa] but fully preserved in Sicily.

Ferula hives from Sicily that I measured were about 82 cm long externally, with a square cross section 23-25 cm, and internally about 3 cm less. The square closure at each end was rebated. The *Ferula* beekeeping described below was done in eastern Sicily, and in the west including the island of Favignana. (Motya, on the coast of Sicily almost opposite Favignana, was a Phoenician and then a Carthaginian city.) It was described by Monticelli in 1807, Buzairies in 1863, Sartori and Rauschenfels in 1878 and Billiard in 1900, and more recently by Birelli (1929), Alber (1953) and Chevet (1993); Burgaretta (1982) published a detailed ethnological study with nearly 100 photographs of equipment and operations. Billiard had said that either end closure could be pushed in to reduce the size of the hive, but this is incorrect.

Operations described below were used by Michele Oliva (1994), a fifth-generation *Ferula* beekeeper; some other beekeepers past and present practised techniques that differed in detail, and all used other specific procedures not described here. All combs were built (square) *across* each hive, as explained below. In spring, when colonies started preparing to swarm, part of each colony was put into an empty hive and a young queen was then reared in the hive without one; new combs were built, and swarming was prevented. The empty hive had been prepared for the new colony by pushing two or three straight rods down through existing holes in the top wall and pressing their ends against the bottom wall; the rods were inserted about one third of the hive's length from each end (at R, R in Figure 22.1c). Then a few brood combs including a queen cell, and some adult bees, were transferred to the empty hive as follows. A (square) comb containing brood was cut out from the front end of a full hive, as for harvesting, and placed upright in the empty hive

* *Ferula communis*, a perennial growing to a height of 4 m; the name *Ferula* (stick) is derived from the rod-like nature of the long flower stalk. It is found on dry stony ground all round the Mediterranean, in many countries of southern Europe and North Africa, and in various Mediterranean islands. In early times lengths of the stalk were used to carry fire from one place to another, because the dried pith (used as tinder) smouldered very slowly within the stem. Hesiod (*c.* 700 BC) recounted that, when the god Prometheus stole fire from heaven, 'he hid fire ... in a hollow fennel stalk so that Zeus who delights in thunder did not see it' (*Works and days*: 50-54).

Figure 22.1d Double shelter holding 400 Ferula hives, Solinaro, Sicily, 1993 (photo: M. Oliva).

from the back,* resting against the rods. It was clamped in place with two cross-sticks whose ends were pressed against the hive walls as in Figure 22.1e; the two sticks were split from the stem of a bamboo-like plant, *Arundo donax* or *Phragmites communis*, and bent after immersion in hot water. The process was repeated until the hive contained 3 or 4 brood combs and finally a comb of honey – all separated from each other (or the end closure) by the cross-sticks. The width of the sticks was such that the combs were properly spaced apart. After the queen had emerged from her cell and mated, the bees would build (square) combs across the rest of the hive beyond the two upright rods. Twelve days later, both hives were again inspected to check that each was queenright and to remove any excess queen cells; like honey bees of Egypt, Sicilian bees produce a very large number of queens (Tiemann & Brückner, 1993).

About 20 square combs a year were harvested from each hive. Hives were taken to mountains when flowers were in bloom there – according to Alber (1969) five on either side of a mule; he found several beekeeping families who kept at least 40,000 hives. Some beekeepers in Sicily have also operated the same system using hives of wooden boards with similar dimensions.

Figure 22.1e *Ferula* hive with front end opened, Solinaro, Sicily, 1993 (photo: M. Oliva). Two bent cross-sticks were wedged in place to support and space each of several combs newly placed in the empty hive, and the final pair can be seen.

* Where the hives were kept in a shelter (Figure 22.1d), any operation done from the back of a hive involved removing it, and therefore any hives above it.

22.14 Other islands

Rhodes and Kos

Rhodes and Kos lie to the west of Cyprus. Several pieces of jewellery from the 600s BC, found at Camiros in Rhodes, show a bee goddess (Ransome, 1937). The *Geoponica* (XV.7.1) noted that honey from Kalymnos in Kos was good, as well as Chutrian honey from Cyprus. No written records of early beekeeping have been found, but horizontal log hives were used in Rhodes in recent times (Ruttner, 1979b).

Malta

The dry and rocky Maltese islands lie between Sicily and Tunisia, and Caius Verres was the Roman Praetor who governed them between 73 and 71 BC. Cicero denounced him before the Senate for various crimes, which included the theft of 400 jars of honey 'for which the Maltese Islands have always been renowned', and he added: 'I do not ask now whence you got those 400 jars of honey' (Laspina, 1950). Cicero knew something of beekeeping, for he said in *De senectute* (XV.54):

> Nor does the farmer find joy only in his cornfields, meadows, vineyards, and woodlands, but also in his garden and orchard, in the rearing of his cattle, in his swarms of bees, and in the infinite variety of flowers.

A bottle-shaped hive of fired clay (*tubo*) was peculiar to the islands in the 1900s. The neck end at the front had a built-in plug, with small entry holes which the bees could defend against hornets. One or more cylindrical extensions could be fitted telescopically to the back of the hive (Figure 38.2c), the wooden closure being transferred from the hive to the extension. Longo (1990) quoted the following external dimensions: hive length 55 cm, diameter 28 cm; extension length 37 cm, diameter 30 cm. From 20 to 50 hives might be kept in a stone bee house, often erected in an angle between two boundary walls. Hives were in 2, 3 or 4 rows, each row on a shelf wide enough to support both hives and extensions. The neck of each hive fitted snugly into a round hole made in the wall of the bee house; alternatively, square holes were made and each fitted with a pottery insert through which entrance holes had been pierced before firing. Some of Malta's many caves were also adapted to serve as a bee house by filling in much of the opening with sandstone blocks, and making flight holes for bees through these. About 3000 traditional hives were still used in the islands in 1970.

Sardinia

Beekeeping was important to the monasteries during Byzantine times (476-1054), and hives were usually kept in an enclosure within stone walls (*ortu de apis*) to deter thieves. In 1316 lands and apiaries in Sardinia were owned by the town of Pisa in Italy. Beekeeping provided a significant addition to the income of rural families which came basically from arable farming and sheep, and until the 1800s this money was used to buy clothes and footwear for the women of the household. Honey was subject to tariffs and customs dues, suggesting that there was a wide market for it (Floris & Prota, 1989).

Unusually in the Mediterranean region, no indication of horizontal hives has been found. In recent centuries upright cork hives had a removable cover, and stood on the ground or on flat stones (Intina, 1884). Honey was harvested by killing the bees (*bogare a mortu*), or by 'beheading' them (*scabitare*) – cutting off the top parts of combs containing honey and leaving the rest for overwintering. In 1977 78% of the hives were traditional ones, but by 1982 fewer than 50%; cork had by then become scarce, and modern hives were promoted as part of an effort to reduce the number of diseased colonies (Prota & Floris, 1983).

Corsica

Corsica, north of Sardinia, was an important source of honey and wax to its various rulers. The island paid both products as tribute to the Etruscans, and after making peace with Rome in 181 BC it paid a tribute of 100,000 pounds (50 tonnes) of wax; two years later the amount was doubled (Livy, XV.34.12; XVII.7.2). It is not known whether these amounts were from natural nests or hives, or both, but the later amount would have corresponded to a honey harvest of perhaps 1000 tonnes, from 100,000 colonies.

James Boswell visited Corsica in 1765, and recorded (1768) that the Fathers at the Franciscan convent at Corte:

> have between 30 and 40 beehives in long wooden cases or trunks of trees, with a covering of the bark of the cork tree. When they want honey, they burn a little juniper wood, the smoke of which makes the bees retire. They then take an iron instrument with a sharp-edged crook at one end of it, and bring out the

greatest part of the honeycomb, leaving only a little for the bees, who work the case full again. By taking the honey in this way, they never kill a bee.

In 1811, Amoretti referred to Corsica – but not Sardinia – as a place where the enlightened old style of beekeeping (i.e. with horizontal hives) was practised. In 1963 I found traditional long hives of wooden boards in a high mountain valley near Sorbollano, similar in appearance to those used in Italy in mediaeval times and later (Section 25.21) and probably also in Antiquity. Horizontal cork hives were still in use in the 1990s. Donnaco (1990) described an old bee house (*arnadjiu*), then roofless, built against a rock slope at E. Caselle south of Corte. Inside were four tiers of recesses, 75 in all, with flight entrances through the wall. Recesses were 70 cm deep, 40-60 cm wide and 35-40 cm high, and long horizontal hives supported in them would have been worked from the back.

Balearic Islands

The earliest record found that relates to bees is from around AD 1100, when honey from Menorca was supplied to the Spanish Courts (Stretton, 1980).

Figure 22.1f shows traditional horizontal hives woven from cane – sometimes split and interwoven round the circumference with leaves from canes or reeds. The leaves might be impregnated with cow dung, and this was smoothed by hand inside to give a bee-tight surface. Hives were 150 cm long, with a volume of about 57 litres; they were made to fit snugly under the standard roof tiles used to cover them, although some hives were kept in open limestone caves. The end closures were of stone; the front one had small entrance holes for the bees, and the back one – removed to harvest honey combs – fitted into a rebate made to receive it. Hives were also made of fired clay, 100 cm long.

Figure 22.1f Traditional woven hives on a platform of stones, Menorca, 1981 (photo: J.F.H. Stretton). See text for details.

Combs were built in any direction, and were cut away from the hive with a long metal tool that had a wide blade at one end and a short cutting edge at right angles to this at the other end. A small bronze cauldron, containing red-hot charcoal sprinkled with dead leaves, produced smoke which the beekeeper blew towards the open back of the hive.

22.15 Summary

Hives used in many of these islands (Table 22.1A) show some close similarities to those in Egypt. They were less varied than hives in lands east of the Mediterranean (Table 21.4A) and – apart from *Ferula* hives in Sicily – showed less innovation. Almost all hives listed for Malta and islands to the east were of earth materials; those in islands west of Malta were of plant materials. Except in Malta, hives had a constant cross-section and were used without an extension. In recent times beekeepers in Sicily could fix combs across the hive, as in Egypt, with resultant benefits that have been explained, and I think it likely that they could also do this in Antiquity.

I also think it likely that hive beekeeping existed in a number of Mediterranean islands before, and perhaps long before, Roman times. The amount of Corsica's tribute to Rome in 183 BC indicates that honey and wax production was then on a large scale.

22.2 Crete

22.21 Crete in Ancient times

Crete was about 650 km north-east of Ancient Egypt, and south of the Cyclades and Aegean islands. It came under direct influence from Egypt between 3000 and 2000 BC, and from 2000 BC it was trading busily with Egypt as well as with Syria, Cyprus and Greece. During the Minoan civilization in Crete, which lasted from about 2600 to 1450 BC, honey was offered to gods, for instance Poseidon, and Eileithyia goddess of childbirth (Chadwick, 1958). Subsequently, Phoenician craftsmen and traders were in eastern Crete soon after 900 BC, and were living there before 800.

Hives excavated in Crete are from Roman times or later (Section 22.22), but it seems likely that hive beekeeping existed in Minoan Crete. The gold pendant in Figure 22.2a was found in 1930 at Mallia, in a burial site used between about 2000 and 1700 BC.

Figure 22.2a Gold pendant showing two bees, from Mallia, Crete, 2000-1700 BC (photo: Archaeological Museum, Heraklion).

Figure 22.2b Tall storage jar with a stool for reaching it, Phaestus, Crete (Pernier & Banti, 1951). The stool has been wrongly identified as a hive (see text).

The two insects, shown face to face, have been much discussed, and interpreted as either wasps or bees (Crane, 1983a), but the more usual deduction was that they are honey bees. Ruttner (1979b, 1980) proposed that they are queens and that the disc in the centre represents a round comb, which could have been produced only across a cylindrical hive, by beekeepers who knew how to arrange this. Section 22.23 explains how it was done in recent times. Other representations of bees have been found on Minoan artefacts, some of which are rather similar to the bees from Egypt in Figure 6.3c; Ransome (1937) reproduced examples. Later Sections suggest that the method of beekeeping in Crete spread from there to Aegean islands, and through them to mainland Greece, where the earliest hives excavated are dated to the 400s BC. Surviving traditional hives in Aegean islands nearest to Crete are most like those in Crete itself (Section 22.33).

22.22 Excavated hives

Hives from Roman and later times have been excavated in Crete, but none from the Minoan period. A cylinder found in the Minoan Palace of Phaestus, which was destroyed in c. 1450 BC, was described as a hive by Mosso (1907) and later by Ransome (1937) and Zymbragoudakis (1979). But it was a standing-stool used to reach into tall storage jars (Figure 22.2b), closed at the top and with a smaller open base which fitted over a raised disc in the paving stones between the jars (Crane & Graham, 1985).

However, excavations in 1950 and the 1980s at several post-Minoan sites in Crete yielded pottery with interior incising, like pottery hives and extensions excavated from Ancient Greece (Section 23.21); such incising helped the bees to attach their combs securely to the hive surface. Some or all of these finds have provisionally been identified as parts of hives and hive extension rings. Dimensions of hives (d), (f), (g) are included in Table 23.2A, and dimensions of extensions (a), (b), (c) and (e) in Table 23.2B. Sites (a)-(d) are in the Knossos area and (e) to (g) at Gortyn. Some of the finds are not yet fully described.

(a) At the kiln site on the south-east slope of Monasteriako Kephali near Knossos (Homann-Wedeking, 1950), a 'remarkably homogeneous' deposit of Hellenistic pottery was found, which included a number of fragments of fired pottery rings dated to between 200 and 100 BC. Diameters varied between 19.5 and 32 cm. Out of 10 deep rings one was complete, and there were also 10 shallower ones; 'Inside, on opposite sides, [were] groups of scratches, usually criss-crossed'. The author suggested that the rings were 'possibly some kind of kiln-prop'.

(b) A small section of a ring of light brown fired clay (P348) was found with domestic pottery from an early Roman house dated to the first century BC, during excavations of a post-Minoan site at Knossos (Catling *et al.*, 1981). There were three grooves on the inner surface of the ring, at right angles to the circumference.

(c) Over 20 fragments of pottery with incising on the interior surface found at the Unexplored Mansion, Knossos, were described by Callaghan (1992) as

Figure 22.2c Part of a vessel from Villa Dionysos, Knossos, Crete, which might be a hive (Hayes, 1983). The external diameter is 20 cm; the original total length is unknown. Scale 1:4.

fragments of hives and hive extension rings. Diameters of the two were similar, between 21 and 30 cm. Complete lengths that could be measured were between 3 and 6.5 cm. All were from the first century AD, during the Roman period.

(d) Hayes (1983), who excavated the Roman Villa Dionysos north-west of the Minoan Palace at Knossos, reported that 'a single fragmentary beehive (71/P35) is present in the main destruction phase'. Figure 22.2c shows this vessel lying on its side like pottery hives in Ancient Greece (Figure 23.2a). The interior surface is scored with shallow incisions which continue round the whole of the circumference. The rim at the mouth, and part of the closed end, were missing, but two holes about 8 mm in diameter were preserved in the end, and possibly another at the centre. There was also a 'suspension hole' near the 'foot' (which might have been used, instead of the system shown in Figure 23.2a(5), to tie on an end closure).

(e) Di Vita (1993) reported finding fragments of many hive extension rings (88 GO 19/1) in excavations on a lower slope of Profitis Ilias at Gortyn, the Roman capital of Crete (Catling, 1989). The site, probably a courtyard of a house, was abandoned in the first century BC.

(f) Figure 22.2d (top) shows a hive (GO 2075) from a proto-imperial tomb at Kolokokià (Di Vita, 1993). Shallow incisions on the interior run parallel along the whole circumference of the cylinder and are cut by others oblique to them. The closed end (base) of the vessel is convex, as is that of the rather similar vessel from the same period, (d) above. A central hole c. 15-18 mm in diameter survives, also two of four smaller holes (c. 10 mm).

(g) Figure 22.2d (bottom) shows a more complete vessel (GO 3986) from room 3 of the Byzantine Houses near the praetorium at Gortyn, 600 years later (Di Vita, 1993). It has numerous groups of incisions on the interior surface, and the knob protruding from the closed end has a 2-cm hole at the centre.

It seems likely to me that the vessels (d), (f) and

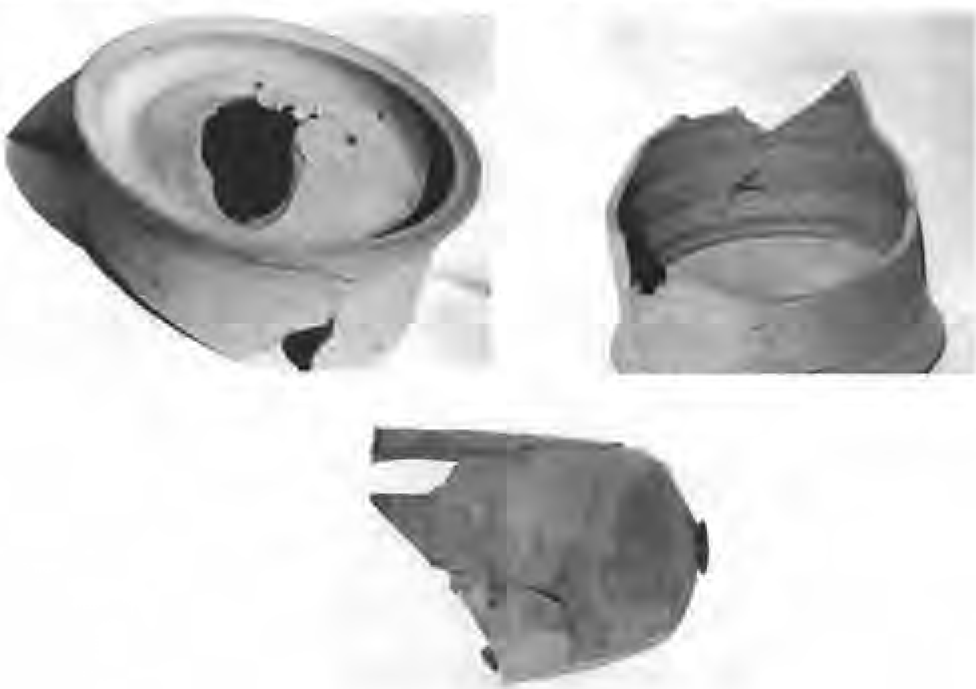


Figure 22.2d Finds excavated from Gortyn, Crete (Di Vita, 1993). *top* Fragment of hive (GO 2075), Kolokokià, with front end uppermost; on right, interior of same fragment (front end down) showing incising. *bottom* More complete hive (GO 3986), Byzantine Houses; front end on right. The top hive is from the Roman period, and the other from the Byzantine period 600 years later.

(g) – at Villa Dionysos, Kolokokià and the Byzantine Houses – may well have been hives which were used on their side, with a closure over the open back, and flight entrance(s) provided by the hole(s) in the closed front. Hives (f) and (g) would then be comparable to recent hives in Kashmir and Malta (Figures 29.5c and 38.2c). Hives from Ancient Greece (Figure 23.2a) had the flight entrance in the closure at the open front end.

J.W. Shaw (1986) reported finds dated between 1500 BC and AD 150 at a site at Kommos on the south coast of Crete near Phaestus, where it is believed that Phoenicians had lived earlier. He described 'large curving fragments of terracotta slabs which, ... when their fenestrations were noticed, were identified as beehives. ... They are hollow [open] at both ends and were provided with little rectangular windows down the side.' One example (K85A/C8334) was part of a vessel with a mouth diameter about 72 cm (J.W. Shaw, 1992), much larger than that of hives excavated elsewhere, and the identification should be reconsidered.

I have found no written reference to the use of extension rings in Crete, and no knowledge of it seems to have survived among present beekeepers.

22.23 Traditional beekeeping in the recent past

Traditional beekeeping survived into the 1900s in Crete. Although it is now done on a smaller scale than that in Egypt, the remembered traditional practices and surviving equipment suggest a long history. At the eastern end of the island bees were sometimes kept in horizontal logs, generally hollowed out from a plane tree because this wood was easy to work (Zymbragoudakis, 1985). In much of Crete a more important type of hive was a horizontal pottery cylinder (*solin*), in principle similar to some of the Ancient Egyptian hives, but flared (Figure 22.2e); Bikos (1994a) photographed many of them in use. External dimensions of 5 hives measured in 1979 were: length 64 to 73 cm, front diameter 29 to 37 cm, back diameter 19 to 23 cm, taper 1 in 18 to 1 in 10. Each end closure was a flat disc of wood or pine bark. The opening at the wider end facilitated removal of honey combs, but – surprisingly – this end was the front of the hive and incorporated the flight entrance. Ruttner (1979b), who described the use of the hive in detail, suggested the following reason for this usage. The only land available and suitable for siting hives in eastern Crete was on cultivated terraces built across mountain slopes. Hives were placed in a row along the top of a terrace wall, facing downhill, and the beekeeper stood on the terrace below to harvest combs; the other (smaller) end was kept permanently closed. For whatever reason the back-handling was sacrificed, the practice of doing all operations from the front of the hive became the norm. In Aegean islands and mainland Greece hives were closed at the narrow end (back) before they were fired.

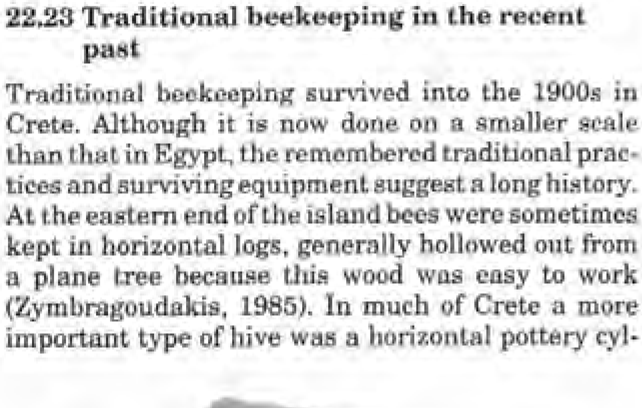


Figure 22.2e Two flared cylindrical hives (*solin*) used in Crete (photo: E. Crane). See text for dimensions.

The flared cylindrical hives were migrated on mules in Crete, and in Ios and some other islands in the Cyclades.

In recent times beekeepers in Crete knew how to transfer combs and fix them across an empty hive before putting bees into it. They fixed these guide combs in position across the hive (in the middle of it), using two dried asphodel stalks, crossed like an X and wedged against the hive sides. The hive was later rotated through 180°, so that comb attachments at the top of the hive were at the bottom, and the bees built further attachments at the new top, resulting in round combs attached to the hive along much of the circumference (Ruttner, 1979b).

Figure 22.2f shows some of the beekeeping tools used in Crete. Comparing them with the Egyptian tools in Figure 20.5c, at the bottom is a sharp flat-bladed tool used in a similar way to Egyptian (5) and/or (6). The scraper in the centre also incorporates a fork, perhaps more effective for a hard pottery surface. The tool at the top has a cutting edge at each end, the two lying in different planes. A ladle for moving bees from one hive to another was not of metal, as now in Egypt (3), but made by fixing a calabash to a long handle. Various smokers were used (Section 34.2) which enabled the beekeeper to blow a stream of smoke into the hive.

Beekeepers in Crete carried home the harvested honey combs in a goatskin bag. Some separated the honey from the wax in a large pottery strainer, which had a feature not known from Egypt: a runnel all

Figure 22.2f Equipment used for traditional beekeeping in Crete (photo: E. Crane). Compare with Figure 20.5c. From top to bottom: Double-ended cutter; Flat-bladed scraper, with fork at other end; Narrow flat-bladed tool, with cutter at other end.

round the wide mouth, which was filled with water to keep ants out of the honey.

In the west of Crete a more advanced traditional hive was also used in which combs were built from top-bars, and were movable (Section 39.3).

22.3 Islands in and around the Aegean Sea

Section 23.3 discusses possible origins of hive beekeeping in these islands.

22.31 Early records relating to bees; beekeeping and honey

About 650 BC on the island of Amorgos in the Cyclades (east of Ios and Naxos), Semonides wrote a poem *Females of the species* which gave moral approval of the honey bee. It opened: 'In the beginning the god made the female mind separately.' He made one woman from a vixen, one from a bitch, and others from other female animals, but all had many faults; then finally, 'Another is from a bee; the man who gets her is fortunate, for on her alone blame does not settle. She causes his property to grow and increase, and she grows old with a husband whom she loves and who loves her, the mother of a handsome and reputable family. ... Women like her are the best and most sensible whom Zeus bestows on men' (Lloyd-Jones, 1975).

Skyros, a relatively isolated island east of Euboea, was noted in Ancient times for its honey, which Horace regarded as fit to rival that from Attica. In *Carmen seculare* (III.2.9) he said that the best island honey of all came from Kalymnos [Calymnium]; this is opposite the peninsula of Asia Minor where Bodrum is situated. One of the earliest surviving references to hive beekeeping in the islands was by Columella in Roman times. In *De re rustica* (IX.14.19) he quoted Celsus as saying that hives of bees were migrated from one part of Euboea to another, and were also taken – it must have been by boat – from islands of the Cyclades to Skyros.

22.32 Excavated hives

Fragments of horizontal pottery hives from the period between 600 BC and AD 400 have been excavated on six islands: Patroclus; Euboea at Eretria (also an extension ring); Makronisos at Diporto; Kea; Delos; Khios at Delphinion. Crane and Graham (1985) cited references. Hive and ring dimensions are known for the finds at Eretria (Tables 23.2A and 23.2B) but not for the others.

22.33 Traditional hive beekeeping in the recent past

Figures 22.3a, 22.3b and 23.2a(8) show recent hives from Syros, Naxos and Antiparos. Hives were kept in recesses in stone walls supporting the terraces on the hillsides in many of the Cyclades which lie between Crete and Attica, including (from south to north) Folegandros, Sikinos, Ios, Naxos, Antiparos, Syros, Tinos, Andros and Kea (Bikos, 1994d). Figure 22.3c shows horizontal hives in their recesses (*melissothyrides*, bee openings) in Andros. Many taller, shallower recesses in Andros housed woven skeps (Figure 32.2f). I do not know of the placing of hives in recesses north of the Cyclades, but according to Nicolaidis (1955) 'tube-like hives' were built into walls in Aegean islands, to protect them from the weather and from theft. Section 23.22 compares the recent hives with those excavated in Aegean islands.

Many recesses can still be seen on Sifnos, near to Crete. The hive there, described by Venieris (1979), was a *solin*, similar to that in Crete but slightly longer, 70 to 80 cm; end openings were 28-35 cm at the front and 18-23 cm at the back (taper 1 in 12 to 1 in 15). One stone disc closed the back end permanently, the other (slightly larger than the mouth) closed the front end and had a V-shaped notch at the edge for a flight entrance, and a circular hole roughly at the centre. Extension rings were added at the front of these hives.

The *solin* was also used recently on Ios (Ruttner, 1979b), but hardly outside the Cyclades. When har-

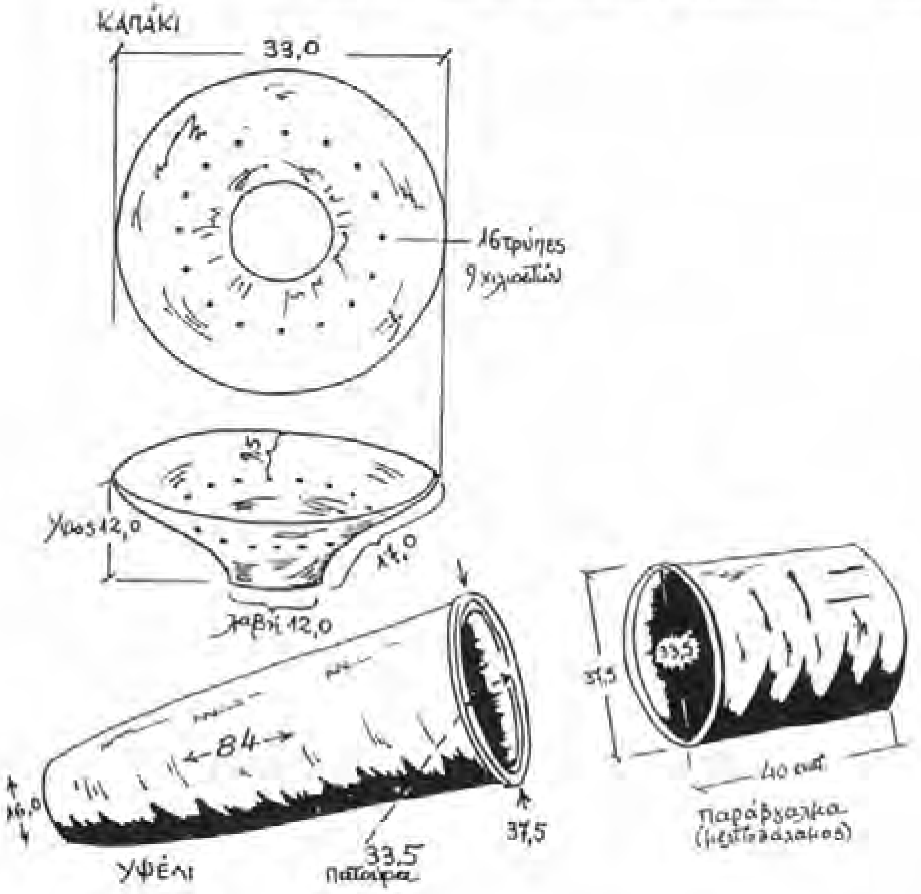


Figure 22.3a Dimensioned drawing of a horizontal pottery hive used in Syros in the 1990s, with its end closure and a deep extension (Bikos, 1994c).

vesting honey combs, the beekeeper removed the closure at the wider end and smoked the bees to the far (closed) end. But according to Nicolaidis (1955), in some places the back closure had an opening through which smoke was blown.

By far the most common traditional hive on Aegean islands today is similar to a *solin* except that the smaller end is closed and often flattened before firing. A hive is sometimes used upright as a storage jar (Showler & Showler, 1985).

In Naxos (Figure 22.3b) the hives were about 100 cm long, with end diameters 40 and 15 cm, giving a more pronounced taper (1 in 8) than in Crete – or in Tinos (below). The front end closure was convex, perforated with many entrance holes which sloped up to the outside to keep enemies out (Bikos, 1981). The closure was not rebated, and a stone was leant against it to keep it in place. In nearby Antiparos, hives were 80 cm long with a mouth diameter of 39 cm (Geroulanos, 1973); see Figure 23.2a(8). Extension rings were not used.

Hives used in Tinos were imported from nearby Sifnos which was noted for its earthenware products, and they were made to quite a close specification. The larger open end had a flared lip to take a round closure (*placa*) made from marble or schist, a stone that can be split into sheets about 10-20 mm thick. The hive was 100 cm long, and 30 cm and 25 cm in diameter at the two ends (taper, 1 in 25). The upper part of the interior was incised so that the bees could attach their combs securely to it, but the extension ring (*prosvoli*) used on Tinos was not incised.

In 1790 della Rocca, Vicaire-Général of Syros, said in Volume II of his book (pp. 15-16) that hives were

Figure 22.3b Pottery hive used in Naxos, Cyclades, 1970s (photo: Th. Bikos).

Figure 22.3c Horizontal hives in 4 of 18 deep recesses at Katakilo in the north-east of Andros, Cyclades, 1994 (photo: Th. Bikos).

made of earthenware, 3 ft [90 cm] long, and round with an external diameter of 1 ft; if one end was made smaller it was 7-8 inches across [20 cm]. The smaller end was normally closed, but a start was being made to construct hives of the same diameter throughout, with both ends open. Shallow incisions were made intermittently over the surface of the upper half of the interior, to which the bees attached their combs.

> Cette partie ... qui recevra les rayons, sera canelée, et ses canelures entrecoupées d'espace en espace: ... la partie canelée sera toujours en dessus; ce sera là que les abeilles placeront leurs rayons avec solidité.

In Plate I of Volume II, della Rocca showed horizontal hives whose end closure containing the flight entrance is convex, like the hives in Syros in the 1990s described by Bikos (1994c) and shown in Figure 22.3a; these were either placed in wall recesses (Bikos, 1991) or covered with piles of wall-stones (Charensol, 1988). Dimensions were: length 84 cm, end diameters 37.5 and 16 cm, length of extension 40 cm (Bikos, 1994c).

23

Traditional Hive Beekeeping in Ancient Greece

23.1 Bees and beekeeping in early writings

Ancient Greek texts about bees and beekeeping have been much studied, for instance by Bessler (1886), Billiard (1900), Klek and Armbruster (1919), Klek (1924), Fraser (1951a), Forbes (1966), Byl (1980) and Davies and Kathirithamby (1986). The earliest written references to hive beekeeping start with myths and legends, and antedate the earliest excavated hives. Honey and beeswax are considered separately here, in Chapters 47 and 49, and knowledge about bees in Chapter 52. Table 52.1A gives dates of many early writers.

The native honey bee in Greece is *Apis mellifera cecropia* in the south and *A. m. macedonica* in the north.

23.11 Writings before Aristotle

Section 7.3 quotes early references to natural nests of bees in Greece and elsewhere. Honey and wax mentioned in Greek legends and stories could have come from either natural nests or hives. In Ancient Greece, the introduction of beekeeping was attributed to Aristaeus, a minor Greek deity of various rustic pursuits, and Fraser (1951a) cited authors who recorded stories about him. From his nurses and tutors, or from the Muses, he learned the arts of healing, prophecy and hunting, and especially the agricultural pursuits of beekeeping, olive growing and cheese making. Some time later his bees began to sicken and die, and all his knowledge could not save them – since a dryad had caused their sickness in revenge for the part Aristaeus had played in the death of Eurydice, another dryad. However, following appropriate advice, Aristaeus sacrificed bulls to the dryads and to Orpheus, and obtained a swarm of bees by the *bugonia* process (Section 52.10). Later he went to Kea, an island off the tip of Attica, then to Sardinia and perhaps also to Libya and Sicily, and wherever he went he taught the agricultural arts to the inhabitants.

C. Boulotis (see Nikiti, 1996) searched Linear B tablets found at Mycenean sites (1400-1200 BC), and found no reference to hives or beekeeping. However, the tablets refer to the offering of hundreds of large jars of honey on a single occasion, so organized honey production must have existed. The tablets also refer to the assessment of olive oil (but not of honey) by age and quality. Honey was traded, but the only mention of its use is mixing it with wine.

What may be the first mention of hives in Greek writings occurs in a passage written about 700 BC, in which Hesiod castigated women by likening them to drones:

> ... as when the bees in their roofed hives feed the drones, which conspire to evil deeds. Every day the bees work eagerly all through the day till sundown and set the white combs, while the drones stay within the roofed hives and gather into their bellies the toil of others. Just so high-thundering Zeus has made women to be an evil for mortal men.
> (*Theogony*, 594-599)

Reasons were given elsewhere (Crane & Graham, 1985) for believing that Hesiod's terms *smēnos* and *simblos* here were specific references to hives.

In 594/593 BC, beekeeping around Athens was on such a scale that Solon passed a law about it: 'He who sets up hives of bees must put them 300 feet [100 m] away from those already installed by another' (Plutarch, *Life of Solon*, 23). In 415 BC, hives were among the property listed on inscriptions in Attica as confiscated from rich and noble Athenians who were condemned as malefactors for committing sacrilege (Prichett, 1953, 1956). About 400 BC Plato bemoaned the deterioration of the land by excessive clearance (*Critias* 111b-d); he referred to 'mountains in Attica which can now support nothing but bees, but which were clothed, not so very long ago, with fine trees ... The country [then] produced boundless pasturage for cattle.'

23.12 Aristotelian writings about beekeeping

Aristotle spent much of his life in Athens, and for a number of years was Plato's pupil and colleague. *Historia animalium* was probably written while he was staying on Lesbos (344-342 BC), when he was about 40. Book V contained much about the life and activities of bees (see Chapter 52), but almost nothing about beekeeping. He referred once to hives: the large 'size of the drone explains why some bee-masters place a network in front of the hives; ... to keep the big drones out while it lets the little bees go in.' (V.22.553b) This network was discussed by Jones *et al.* (1973); perhaps it was put in place to keep out (large) hornets, and someone who noticed drones flying against it from outside assumed that its purpose was to exclude them.

Beekeeping was dealt with in Book IX, written at about the same period by an unknown author sometimes referred to as Pseudo-Aristotle. The beekeeping material is very disorganized, like the rest of the book (see Jones *et al.*, 1973). It sets out the needs and capabilities of bees.

> A hive yields to the beekeeper 6 or 9 pints of honey; a prosperous hive will yield 12 or 15 pints, exceptionally good hives 18. (IX.40.627b) [These amounts would weigh 5-7, 10-12, 14 kg.]

> When the bee-masters take out the combs, they leave enough food behind for winter use; if it be sufficient in quantity, the occupants of the hive will survive; if it be insufficient, then, if the weather be rough, they die on the spot. (IX.40.626a)

> [The bees] become somewhat lazy if the beekeeper ... leaves behind too much honey, ... [but] work in a spiritless way if too few combs are left. They become idle also, as being dispirited, if the hive be too big. (IX.40.627a-b) They suffer most from hunger when they recommence work after winter. (IX.40.627a) When honey runs short ... the beekeepers supply the bees with figs and sweet-tasting articles of food. (IX.40.626b)

> When the bees inside the hive hang clustering to one another, it is a sign that the swarm is intending to quit; consequently beekeepers, on seeing this, besprinkle the hive with sweet wine. (IX.40.627b)

> Beekeepers entrap [wasps] by putting a flat dish on the ground with pieces of meat on it [and finally putting all on the fire.] (IX.40.627b)

> The cells for the drones are larger than the others; usually [the bees] put them amongst their own [cells]; and when this is the case the beekeepers cut the drone-cells out of the combs. (IX.40.624b)

The passages show that a beekeeper got a fairly substantial honey yield from a hive, took care to leave the bees enough food throughout the year and also protected them from their enemies. He used smoke to subdue the bees (Section 23.23).

Nowhere is there any clue as to what the hives were like, although if they were all of the same type a description may not have been considered necessary. Aristotle wrote so much about bees (Chapter 52) that there have been many discussions in recent years as to the hives he knew and possibly observed bees in (Fraser, 1951a; Jones *et al.*, 1973; Graham, 1975; Crane, 1983a; Crane & Graham, 1985; Davies & Kathirithamby, 1986). It seems to me that what he knew about bees – and more – could have been observed with hives like those in Figure 23.2a; examples of these hives dating from his lifetime have been excavated at several sites in and around Athens.

23.13 Later writings in Ancient Greece

Theophrastus (372-288 BC), who inherited Aristotle's library including his manuscripts, is reputed to have written 227 works. Most of those surviving are on plants, and they include contemporary ideas on the origins of honey (Section 52.93). The most important books on beekeeping in Ancient Greece were probably those written by Aristomachus and Philiscus during the Hellenistic period, between about 330 and 30 BC. They were lost, although we do not know when or how. Pliny and Columella in Rome referred to the authors.

> Nobody must be surprised that love for bees inspired Aristomachus of Soli to devote himself to nothing else for 58 years, and Philiscus of Thasos to keep bees in desert places, winning the name of the Wild Man; both of these have written about them. (Pliny XI.9.19)

Both Aristomachus and Philiscus came from regions distant from Athens and Attica. Soli is at the east end of the south coast of Asia Minor. The island of Thasos is at the very north of the Aegean Sea, off the coast of Thrace; it is now – and may have been then – a prolific source of honeydew from the pine *Pinus halepensis*.

Nicander of Colophon in Asia Minor, who was ac-

tive around 135 BC, wrote *Melissourgika*, another beekeeping book which was lost, but references to bees in some of his other works suggest that it was not an important one.

23.2 Traditional beekeeping using horizontal pottery hives

23.21 Hives excavated in mainland Greece

This Section is concerned with specimens of horizontal pottery hives excavated in the south-east of mainland Greece, and dated to periods between 500 BC and AD 600; Figure 23.2a shows several examples. Table 23.2A gives dimensions of hives from mainland and island sites which were sufficiently complete to be measured.

The story behind the above discoveries is as follows. In the 1960s a house excavated at Vari on the southern slope of Mount Hymettus, south of Athens, had been occupied between 350 and 275 BC (and thus during the latter part of the life of Aristotle). Some of the finds were pieces of coarse pottery jars: tall, with a wide mouth surrounded by a protruding lip, and no handles (Jones *et al.*, 1973; Graham, 1975). An unusual feature of most of the jars and fragments was that shallow incisions had been made before firing, over about half of the interior circumference, as if by a comb drawn through the wet clay surface.* The incisions are often rather intermittent, and their direction may be along the length, or at right angles to it, or both. They always

*The term *combing* has sometimes been used for the process that makes these marks, but in this book - to avoid confusion with combs the bees build - the marks are referred to as incised lines, or shallow incisions.

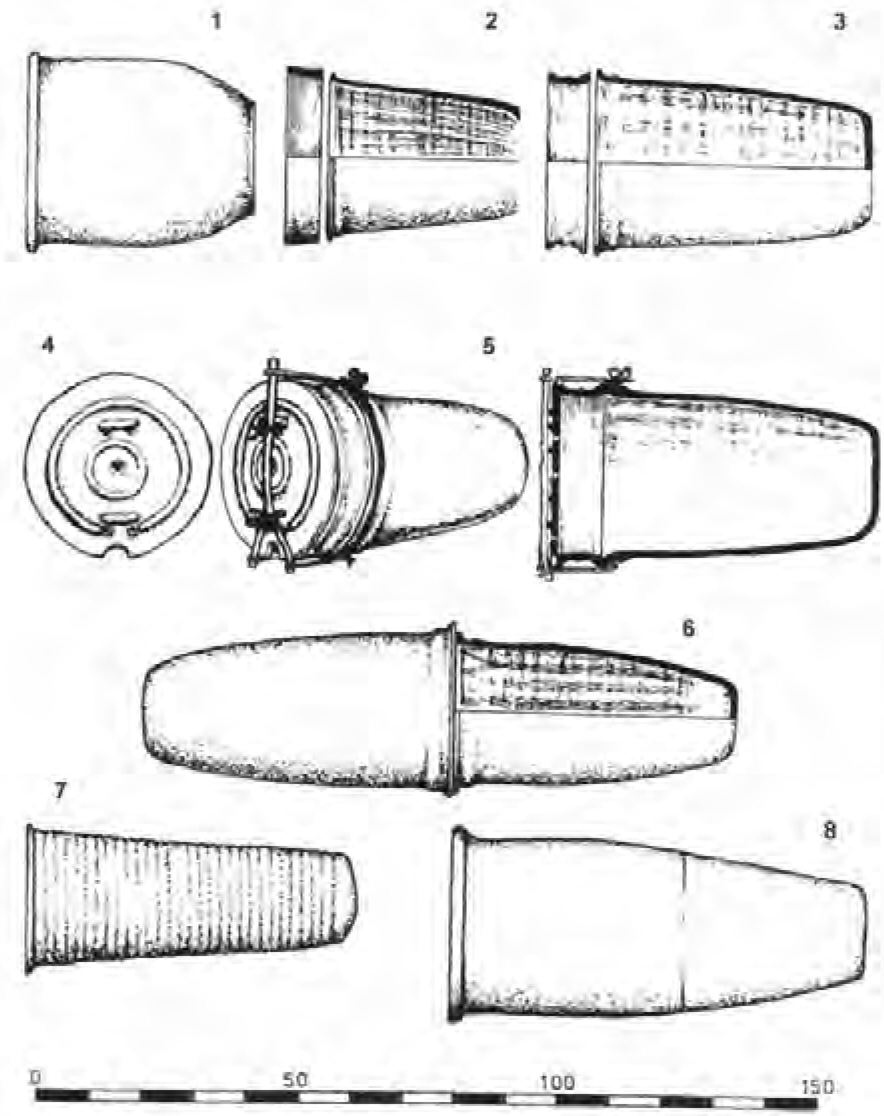


Figure 23.2a Some horizontal pottery hives from Ancient Greece (original scale drawings: J.E. Jones; scale in cm). Dimensions are given in Table 23.2A.

(1) -425 to -400, in Agora Museum, Athens (P11017)
(2) -350 to -275, hive with extension found at Vari
-400 to -300 hive found at Trachones:
(3) hive with extension
(4) closure
(5) two views of suggested fastening (see Section 23.22 *Hive closures*)
(6) -200 to -100, boy's coffin made from two hives, found at Marathon
(7) +550 to +600, one of 4 hives from Isthmia
(8) +1973, hive in use on Antiparos

Table 23.2A

Horizontal pottery hives excavated in Greece, Aegean Islands, Crete and Cyprus

Hives in each region are listed roughly in date order. Inventory numbers P11017, etc., indicate hives in the Agora Museum, Athens.
Entries for Greece are from Crane and Graham (1985).
Finds in Crete and Cyprus are described in Sections 22.22 and 22.12, respectively.
The Table includes only hives whose dimensions (cm) could be established.

Place	*Date*	*Length*	*Mouth diameter*	*Interior incising**
Greece, Attica				
Thorikos:				
TC63.168	–500 to –400	60	28	half+
TC77.95	–500 to –400	c.50	29	half
P11017	–425 to –400	44	39	<half
Trachones	–400 to –300	54	37	1/3
Vari	–350 to –275	40-45	33-39	c.half
P16286	–300 to –200	36	34	2/3
Marathon	–200 to –100	59	35	yes
Marathon	–200 to –100	55	30	yes
P28483	–200 to –100	41	37	3/4
P14453	?–300 to –1	47	36	half
P7976	early Roman	64	32	
P5824	–100 to –1	46	38?	half
P21772	c.+1 to +50	57	33	half
Greece, Isthmia				
	+550 to +600	63	30	half
	+550 to +600	63	29	half
	+550 to +600	60	30	half
	+550 to +600	57	32	half
Greece, Euboea				
Eretria	–400 to –370	39	37	yes
Crete, Knossos				
(d) Villa Dionysos 71/P35	Roman	unknown	ext.20	yes
Crete, Gortyn				
(f) Kolokokia GO 2075	+1 to +200	>17	ext.23 int.18.8	yes
(g) Byzantine Houses GO 3986	+650 to +700	30	ext.24 int.21.6	yes
Cyprus				
P333	+650 to +750	>22.5	34	yes
P255	+650 to +750		38	yes
Hives in recent use, Aegean and elsewhere				
Syros	1790	80	front 20 back 30	yes
	recent	84	ext.37.5 int.33.5	
Antiparos	recent	80	39	none
Tinos	recent	100	30	?
Sikinos	recent	70-80	28-35	?
Crete	recent	64-73	front 29-37 back 19-33	no?
Cyprus	recent	60-70	front 25-28 back 28-32	no?
Kashmir	recent	50	e.g. 35	<half

* The incising always covers the whole length of the hive interior; the proportion of the circumference covered is entered if known.

extend over the full height/length of the jar, but never over much more than half the circumference (Table 23.2A). If the jars had been made for use as horizontal hives, and placed with the incised surface uppermost, this would provide the bees with a roughened surface to which they could attach their combs securely. The identification of the jars as hives for bees was confirmed when fragments examined by gas chro-

matography showed traces of beeswax on those jars (Figure 23.2b), but on no others.

Once these jars were known to be hives, a number of other jars with shallow incisions on the internal surface could be similarly identified. They included some excavated at other sites in mainland Greece, a few at island sites (Chapter 22), and a large number in eastern Spain (Section 21.7). Figure 23.2a(1) shows the earliest of the hives in the Agora Museum in Athens, most of which were catalogued as *kalathos* (jar shaped like a basket), and two as umbrella stands. A fragment of one jar with shallow incisions was found under the (sealed) floor of the house at Vari, and dated to an earlier occupation of the house between 450 and 400 BC.

Detailed descriptions were published of hives and extensions found at Thorikos, with drawings and photographs (Jones, 1990). At Marathon two virtually complete hives (Figure 23.2a,6) had been used mouth to mouth to form a coffin for a boy about 7 years old (Jones, 1976). Several hives found at the House with Mosaics at Eretria on Euboea seem to have been new and in storage when the House was destroyed by fire about 400 BC (Ducrey & Metzger, 1979).

Remains of hives have been excavated at other sites than those in Table 23.2A, but the hive dimensions are not fully known; Crane and Graham (1985) showed the sites on a map and cited references.

Attica
Aegaleus Tower
Agrileza, and Soureza nearby (also extension)
Dema Tower (also closure)
Eleutherae
Helioupolis (–265)
Hymettus Tower
Kastraki
Koroni (–265)
Kynosoura
Mount Beletsi
Philaidae, Vrauvron (also closure and extension)

Attica (cont.)
Phyle
Thriasian Lager
Yerovouno

Aegean Islands
Delos
Kea
Khios, at Delphinion
Makronisos, at Diporto
Patroclus

Catling (1989) listed the following recently reported finds of 'beehives', whose dimensions were not yet published. B. Petrakos found 'pieces of beehives' dated to the 300s BC at an isolated country house at Pasha Limani in south-east Attica; photographs show shallow incisions on the interior surface of curved pieces (some with a rim) and on pieces of a flat base. E. Touloupa found a small coffin made from two hives placed mouth to mouth on Euboea; it was dated to between 600 and 400 BC.

A large jar dated to *c.* 1600-1500 BC, found in pieces at Akrotiri on Thera, was wrongly identified as a hive by Doumas (1976); it was a lidded strainer with a perforated base some distance above the bottom of the jar.

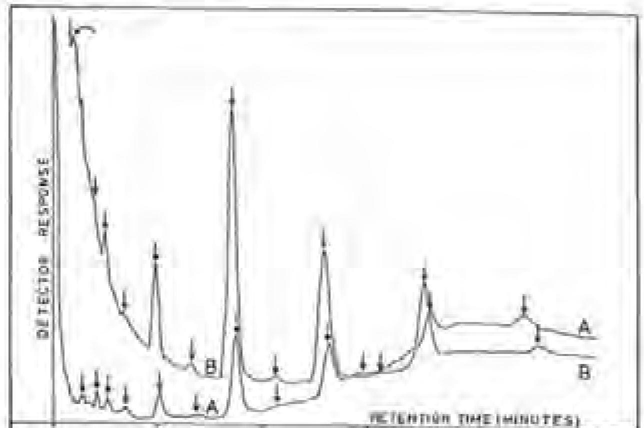


Figure 23.2b Specimen gas chromatogram (B) of material extracted from vessels found at Vari, now identified as hives, and (A) of standard beeswax (Graham, 1973).

23.22 Excavated hives in the light of recent beekeeping with similar hives

The use of horizontal pottery hives seems to have died out in mainland Greece, but it continues in some Aegean islands (Section 22.33), and we can compare recent hives in these islands with Ancient hives there and in the mainland. Like Ancient hives, recent hives are slightly wider at the front end which contains the flight entrance, and they are worked only from the front. In some islands to the south, e.g. Crete, Ios and Sikinos, the hive is now fired as an open cylinder, but in most islands the (flat) smaller end is closed before firing. Section 22.22 describes in detail the hives excavated in Crete, and Section 22.23 discusses recent traditional beekeeping there.

Dimensions of hives

Table 23.2A gives the length and mouth diameter of hives excavated in mainland Greece and of similar hives used recently on Aegean and other islands. The mouth diameter of excavated hives is between 28 and 39 cm and shows no consistent change over the centuries. The diameter of hives in recent use is rather similar, although three in Crete are smaller. On the other hand the later hives are longer:

7 hives between *c.* –400 and –200	average 47 cm
7 hives between *c.* –200 and –50	50 cm
4 hives between *c.* +550 and +600	61 cm
several hives, late 1900s	70-100 cm

In Tinos, recently made hives are housed in wall recesses built by past beekeepers and protrude from them, suggesting that there has been an increase in hive length during the past few generations.

Over the centuries, beekeepers in many regions learned to develop and manage larger colonies, in larger hives, which could yield more honey. If the diameter of horizontal hives was increased, combs would be larger and more inclined to break or buckle, but increasing the length of the hive would not have this disadvantage.

Hive extensions and their dimensions

In Figure 23.2a, drawings 2-5 show a pottery ring used to extend a hive during a honey flow. Extension rings or fragments of them, dated to about 275 BC or earlier, were found at some sites in or near Attica where hives were excavated (fragments from Vari were tested and showed traces of beeswax). Extension rings have also been excavated in Euboea and Crete. Table 23.2B gives dimensions of rings from eight mainland and island sites.

The rings had a lip at each end, and the diameter was normally that of the mouth of the hive. Most extensions were shallow (short), adding 7-10 cm to the length of the hive, but one find at Thorikos from the 400s BC, and one at Knossos from the 100s BC (a) were more similar to longer ones used in a number of places in the 1900s (Figures 22.3a, 29.5c, 38.2c). Extensions were added to traditional hives in many countries to the east of the Mediterranean; see Table 21.4A.

Hive closures

Purpose-made pottery closures for the mouth of a hive were found at 5 Ancient Greek sites, all in Attica, and some were dated to the 300s and 200s BC. None have yet been found in islands, where closures now used are mostly simpler than those excavated in mainland Greece: discs made of pottery in Naxos, stone in Sikinos and Tinos, wood in Crete and Antiparos. In Tinos (and in Crete) the closure is rebated to fit inside the hive rim. Figure 22.3a shows an elegant convex pottery closure in Syros.

Closures excavated with hives in Greece (Figure 23.2a,4,5) were circular and fitted flush over the mouth of the hive. They had two concentric ridges, a small central hole, a U-shaped notch at the edge, and also several holes about 2 cm in diameter: 2 or more in line, or two pairs. Comparison with hive closures used currently in Aegean islands suggests that the notch was the flight entrance, and the central hole was for ventilation and upon occasion a second entrance. Jones *et al.* (1973) suggested that the 2-cm

Table 23.2B

Dimensions (cm) of pottery hive extension rings excavated in Greece, Aegean islands and Crete

Table 23.2A lists hives excavated, and Section 22.22 describes the finds in Crete

Place	*Date*	*Length*	*Diameter*	*Interior incising*
*Greece**				
Thorikos	–500 to –400	30-30.5	29-32	yes
Euboea, at Eretria	–400 to –370	9	37?	yes
Trachones	–400 to –300	7-10	36-41	yes
Vari	–350 to –275	7-9	32-40	yes
Crete, Knossos				
(a) kiln site	–200 to –100	3-5.5	21-25.5	yes
		5.5	32	yes
		unknown	19.5-24	yes
		unknown	30.5	yes
		24	24	
(b) Roman house	–100 to –1	4.5	unknown	yes
(c) Unexplored Mansion	+1 to +100	3-6.5	23-28	yes
Crete, Gortyn				
(e) Profitis Ilias	–300 to –1	5.5	int.21.5-22	yes
Extension rings in recent use				
Tinos	recent	up to 30	30	?
Syros	recent	up to 40	ext.37.5 int.33.5	?
Kashmir (mud)	recent	c.16	e.g. 35	yes

* Extension rings were also found at Athens.

holes were needed for fixing the closure tightly across the mouth of the hive – or of the extension if one was in place, as in the Figure 23.2a,5.

Shallow incisions on the interior hive surface

The presence of these incisions was a significant factor in identifying excavated vessels as hives (Section 23.21). In 1790 the upper part of the interior surface of hives was incised in Syros (Section 22.33), and this was also done in the late 1900s (Bikos, 1996). Hives now used in Crete and Antiparos have no incisions, although there are slight ridges round the whole circumference, as is usual in such pottery.

Many hive extensions were incised over the entire interior surface, so any part of the ring could be placed uppermost.

Direction of comb building

In order to get the combs built *across* an added extension ring (parallel to the mouth), so that they can be harvested intact by removing the ring, it is necessary to get the bees to build their combs across the hive itself. (I kept bees in a reconstruction of a hive from Vari but did not control the direction of comb building, and harvesting combs from the extension was a very messy business.) Beekeepers in Ancient Greece – at any rate in Attica – could presumably do this, otherwise shallow hive extension rings would have been impracticable. Della Rocca's 1790 description of beekeeping on Syros quoted in Section 22.33 shows that beekeepers there could do it.

23.23 Some other aspects of traditional beekeeping

Beekeepers used smoke, and the famous orator Zonas of Sardis in Asia Minor (c. 80 BC) concluded a poem addressed to the 'tawny hive bees' with the hope that the beekeeper, 'smoking you out with his skilful hand, may leave a little portion [of honey] for you also'. The author of *Historia animalium* Book IX (40.623b) observed accurately that the bees 'devoured the honey most ravenously' after being smoked.

After combs were taken out of the hive, honey was extracted by squeezing or pressing them: Apollonides referred to old Cliton the beekeeper 'pressing much honey from the ambrosial combs' (*Anthologia Graeca* VI.239). Both the honeys and the beekeepers retained their prestige in later years: Synesius, a Christian who visited Athens in the 400s, remarked that 'the glory of its philosophers had departed, but that of its bee-masters still remained'.

During Roman times, Celsus referred to migrating hives in Greece. In recent times, a hive used for migration on Tinos was marked to indicate the top, so that it was always placed the right way up, and this was probably an ancient practice.

In islands where the land is terraced, hives are now placed in individual recesses in a wall (in the Aegean) or in a single row on top of the wall (in Crete, Section 22.23). We do not know how hives were positioned on flat land in Ancient mainland Greece. In other regions, where hives could be opened at the back as well as the front, they were commonly stacked in three or more tiers, either 'loose' or built into a wall.

23.3 What was the origin of hive beekeeping in mainland Greece?

Horizontal pottery hives that could be opened only from one end are known from before 400 BC in Greece, and the greatest number were found in Attica. The fact that extension rings have also been found suggests that the beekeepers knew how to ensure that bees built their combs *across* the hive. We do not know how this was done in Greece, but methods used recently in Egypt, Arabia, Sicily and Crete are described in earlier Chapters.

Sections in Chapters 22 and 23 have described features of both excavated and currently used hives in Crete, some of the Aegean islands, and mainland Greece. We do not know when hives were first used in Crete, but Ruttner's (1980) interpretation of the design of the gold pendant found in Mallia (Figure 22.2a) supports the possibility that horizontal cylindrical hives were used as early as the Minoan period (2600-1450 BC). Crete came under influences from Egypt between 3000 and 2000 BC, and also traded with Greece and Cyprus from 2000 BC (Section 22.21). Features of the various hives in these regions and similarities between them suggest that knowledge of hive beekeeping was transmitted from Crete to nearby Aegean islands and thence to other islands and mainland Greece.

Section 24.4 discusses beekeeping described in Ancient Rome in relation to that in Ancient Greece.

24

Traditional Hive Beekeeping in the Roman World

24.1 Surviving Roman books which include beekeeping

It is possible to build up a vivid picture of hive beekeeping in Ancient Egypt from the contemporary representations of it and the traditional beekeeping that still exists. In Greece we can handle excavated hives that were used before, during and after Aristotle's time, and we can still see beekeeping with hives like them in some Aegean Islands. But no pictures of beekeeping are known from Ancient Rome, and it is unlikely that hives used in Italy at that time would survive, because almost all were of plant materials and thus biodegradable. However, pottery hives from the Roman period have been excavated in Spain, and the many extant Roman writings tell us more about beekeeping methods, and the authors' ideas and attitude to bees, than hives or pictures could ever do.

Much knowledge existed within the Roman provinces, and after 133 BC these included Italy with Sicily, Sardinia and Corsica, much of North Africa including Carthage, most of Spain and, in the east, Phoenicia, Macedonia and the west of Asia Minor. Some of this knowledge was recorded in writings by Roman authors and thus passed on to future generations, and the writings had an outstanding influence on beekeeping over a large area, throughout the Middle Ages and afterwards.

Table 24.1A shows materials mentioned by major Roman writers. Most were in use somewhere in the Mediterranean region before Roman times: horizontal hives of earth materials (sun-dried mud and pottery) and of plant materials (cork, *Ferula*, woven wicker, log). It seems likely that Roman writers described what they had seen or read about in some other regions, as well as what they used themselves, but they rarely stated where a certain type of hive was used. Hives of wooden boards, or brick, or partly of transparent materials, may perhaps have been first used in Rome, but those of pottery, cork or *Ferula* may never have been seen there. None of the

Table 24.1A

Materials used for traditional hives referred to by five Roman writers

The hives, all horizontal, are listed in Columella's order, and mainly in his order of preference.

Type of hive	*Varro*	*Virgil*	*Columella (and if preferred)*	*Pliny*	*Palladius*	*Figure numbers of similar, usually later, hives*
Plant materials (biodegradable)						
bark (cork)	x	x	x (yes)	x	x	21.6a, 28.3e
plant stems (*Ferula*)	x		x (yes)	x	x	22.1c, 22.1e
woven wicker, etc.	x	x	x (yes)	x	x	21.4c, 29.2b, 32.2k
wicker, 'most narrow in the middle'	x					28.3a
hollowed log	x		x		x	28.3f, 29.2a
wood (boards)			x		x	25.2a
dung			x (no)			
Earth materials (not biodegradable)						
pottery (fired clay)*	x		x (no)		x	21.6a, 29.5b
brick			x (no)			
transparent				x		
Earth materials (biodegradable)						
sun-dried mud*						20.5b
Hive size adjusted by moving end closures			x (yes)	x		

* Columella's word is *fictilis*; if it included sun-dried mud as well as fired clay, the two entries marked * should be combined.

hives described are now used around Rome, and few of them in Italy, but each type can still be found in regions that were once peripheral parts of the Roman Empire, or lay beyond it, and illustrations of them in this book are indicated in Table 24.1A.

Soon after Carthage in North Africa fell to the Romans, in 146 BC, Mago's treatise on agriculture – written, possibly much earlier, in Phoenician (Section 21.5) – was translated into Latin by order of the Roman Senate. It was one of the most important books in Roman times, and all later agricultural writers drew on it; according to Tilly (1973) 'it must have exercised an incalculable influence on the practice of Roman agriculture'. The book included beekeeping.

Five Latin books on agriculture and two on natural history have survived from Ancient Rome. The earliest, written by Cato about 160 BC – before Mago's book was available in Latin – did not include beekeeping. The surviving books with sections on beekeeping, with those known but lost, are listed below, and Table 52.1A includes a few other sources.

Date	*Author*	*Book*
–234 to –149	Cato	*De agri cultura*, no beekeeping
after –146	Mago	lost Latin translation of Mago's great book on agriculture, written in Phoenician before –146; see Section 21.5.
–116 to –27	Varro	*Res rusticae*, Book III.16
–70 to –19	Virgil	*Georgics*, Book IV
1st century BC	Hyginus	*De agricultura*, book lost
c. +30	Celsus	book on agriculture, lost
c. +60	Columella	*De re rustica*, Book IX.2-16
+23 to +79	Pliny (the Elder)	*Naturalis historia*, Book XI.4-16; also XXI.43-49 and some later paragraphs
died *c.* +220	Aelian	*De natura animalium*, scattered references
+300s	Palladius	*Opus agriculturae*, scattered references

Most of our knowledge of Roman beekeeping practices comes from the above books, and English translations of the main passages by Varro, Virgil, Columella, Pliny, Aelian and Palladius were recently collected together (Crane, 1994). Fraser's *Beekeeping in antiquity* (1951a) discussed bees, beekeeping, honey and beeswax as dealt with in the texts, and earlier commentaries were written by Billiard (1900) and Klek and Armbruster (1919/21). Whitfield (1956) examined the copying by one Roman writer from another.

Cato

Marcus Porcius Cato had a distinguished military career in North Africa, Spain and Greece, and could well have seen beekeeping in these regions. But he did not mention it in *De agri cultura*, his only book to survive, and the only links with it are a recipe that includes beeswax for cement to mend wine jars, and several food recipes that include honey. For instance to make Punic (Phoenician) porridge, 3 pounds of fresh cheese, ½ pound of honey and 1 egg are mixed with 1 pound of groats (milled grain) presoaked until they are soft.

Varro

Marcus Terentius Varro (a contemporary and acquaintance of Cato's great-grandson) was born in Rome in 116 BC; he studied in Athens and later served as Roman legate in Spain, and he may have travelled and fought in other countries to the east of Rome. He observed and recorded wherever he went, and he was one of the greatest of Roman scholars, credited with writing 620 books. Of this immense output, only his book on agriculture (*Res rusticae*) survived in its entirety; it appeared in 37 BC, ten years before he died at the age of 90. Varro was able to spend his last years in the quiet of his country estates, reading and writing in his study beside a stream, and enjoying the birds and their singing (Tilly, 1973).

Varro referred several times to Mago's book and gave it high praise. In Book I of *Res rusticae* (1.10), when listing the previous writers on agriculture, he said that all 'are surpassed in reputation by Mago of Carthage, who gathered into 28 books, written in the Punic tongue, the subjects they had dealt with separately'. Nevertheless in Book III (2.13): 'the Carthaginian Mago, Cassius Dionysius and other writers have left in their books remarks on them [cattle-raising, chickens, pigeons, bees, and the like], but scattered and unsystematic.' Varro did not mention the lost Greek beekeeping books by Aristomachus and Philiscus (Section 23.13), although Columella and Pliny did so a century later, and he may have been unfamiliar with them.

Tilly (1973) published the Latin text of Varro's *Res rusticae*, with an English summary and notes. Book III, on rearing small livestock on the home farm, included bees. It gave instructions for smoking and examining bees in the hive; cleaning hives and moving them; providing the bees with food and water; hiving a swarm; taking the honey. Columella dealt with most of the subjects in more detail.

Varro's passage on hives (III.16.15-17) is quoted below, and Table 24.1A lists Figures in the present book which show similar hives used in various regions.

Some make them round out of withies,* some make them of wood and bark, some from hollow trees, some of earthenware, and others again from the fennel plant, making them rectangular, about three feet long and one foot across except that, when the bees are too few to fill them, they reduce the size, so that they do not lose heart in a wide empty space. All these vessels are called *alvi* from the nourishment (*alimonio*) of the honey, and it seems that they make them most narrow in the middle, in order to imitate the shape of the bees. The wicker hives [not those of earthenware, as in Fraser, 1958] they smear with cow dung within and without, so that the bees are not frightened by their roughness. They place the hives on ledges on a wall in such a way that they do not shake and do not touch each other, when they have been placed in the row. They make similarly a second and third row below, leaving a space between the rows, and they say that one should rather reduce this number than add a fourth row. In the middle of the hives they make small holes right and left, by which the bees may go in. At the ends, where the beekeepers may take out the comb, they place lids.† The best hives are made of bark, the worst of earthenware, because those ones are most affected by the cold of winter and the heat of summer.

Virgil

Virgil (Publis Vergilius Maro), 46 years younger than Varro, was born near Mantua and lived until 19 BC. He was educated in Italy, and later had a villa in Naples and a country house near Nola. Virgil was one of the greatest of the Latin poets, and his renowned descriptions of bees have been loved by generations of beekeepers. His treatise on agriculture, the *Georgics*, was prepared at the request of Maecenas and appeared about 30 BC. It consisted of four books in verse, discussed by Billiard (1928); the Fourth, on bees and beekeeping, drew much on Varro's work which appeared seven years earlier; Whitfield (1956) tracked down other sources available to Virgil. The following passage is based on the Aristotelian *Historia animalium* IX.623-625, and the 'division of labour' in the hive which it describes is referred to again in Sections 52.31 and 52.41.

*Withies are tough flexible branches, especially of willow or osier, plaited or woven to make *wicker*.

†'Ends' is used here for *extrema* and 'lids' or 'closures' for *opercula*.

For some preside
O'er getting of the food, and duty-bound
Are busy in the fields; others indoors
Fix tears of daffodils and tough bark-glue
For bases to the combs, then hang thereto
The sticky wax; and some escort abroad
The grown-up sons, the city's hope and crown;
And others pack the honeyed excellence
Close, with pure nectar plumping every cell;
And some by lot are warders of the gate,
And scan the clouds in turn and watch for showers,
Or else relieve home-comers of their load,
Or all unite and chase the lazy drones
Across the border ...
(lines 156-168, translated by T.F. Royde)

Columella

Lucius Junius Moderatus Columella, a Spaniard born in Gades (Cadiz) in the first century, learned agriculture from an uncle. He settled in Rome, when the Empire included further territories: the rest of Spain, Gaul, the Low Countries and parts of Britain; eastern Europe as far north as the Danube; the rest of Anatolia, the eastern Mediterranean seaboard, and Egypt.

Columella wrote more methodically and professionally than other Roman beekeeping authors, and with a greater attempt at completeness. By his time more Roman sources could be called on, including two books subsequently lost which dealt with bees and beekeeping: *De agricultura* by Gaius Julius Hyginus, a contemporary of Virgil, and an encyclopaedic work by Celsus (c. AD 30). In *De re rustica* Columella acknowledged his debt to Hyginus, who wrote with great care and 'industriously collected the opinions of ancient authors dispersed in their different writings', to Virgil who wrote ornately and 'embellished the subject with the flowers of poetry', and to Celsus who wrote elegantly and 'applied the method of both the above-mentioned authors'. Columella gave a considerable amount of information in addition to that taken directly from these authors. He devoted the final Book of *De re rustica* (IX) entirely to beekeeping, except for a short Chapter on the care of wild cattle. There were no chapter titles, but those below (based on Fraser's, 1951a) show Columella's systematic treatment, which was followed in principle by later textbooks in many countries.

2. Authorities and origins; 3. Races of bees; 4. Bee plants;
5. The apiary; 6. Hives; 7. Stands for hives;
8. Buying and collecting bees; 9. Swarms;

10. King-bees [Queens]; 11. Requeening and uniting colonies;
12. Restless swarms; 13. Bee diseases;
14. The year's work; 15. Honey and honey harvesting;
16. Extracting beeswax.

Columella understood that bees need water to rear brood: 'without which neither combs nor honey nor even young bees can be formed' (IX.5.5). His passage about hives and their materials (IX.6.1-2) is more detailed than Varro's.

> Bee hives are to be made according to the character of the region. If there is an abundance of cork trees, we shall certainly make the most useful hives from their bark, because they will not be cold in winter nor hot in summer. If there are plenty of fennel stalks, good vessels for bee hives can be constructed out of them, because they have similar natural properties to cork. If neither of these materials is available, they can be woven out of withies by means of basketwork. If this material too is not available, they will be made out of wood, either a hollow tree or from wood cut into boards. The earthenware hives have the worst properties, because they are burnt by the summer heats, and frozen by winter's cold.

Columella agreed with Celsus in his disapproval of hives of dung because they could catch fire, but suggested protecting them with a (fireproof) brick wall. Brick hives were acceptable to Celsus, although they could not be moved, but to Columella mobility was essential for the good of the bees: 'the question arises as to what ought to be done for the sake of the bees themselves, when it is advisable that they should be sent to another district because they are suffering from disease or from the barrenness and poverty of the locality' (IX.6.3).

Columella went further than Varro and Virgil in explaining how hives (of any type) were to be arranged:

> [on] a platform made of stone contructed across the whole apiary, three feet high and three feet wide. ... On it are placed the hives ... [each] walled round except at the front and back; or arranged in a row and held firm by bricks or concrete, in such a way that the individual hives are contained by two narrow walls, and both ends are left free. For the hives must sometimes be opened at the front from which the bees issue forth, and much more frequently at the back through which the colony is repeatedly tended. But if no walls are interposed between the hives, they must be positioned in such a way that there is a small distance between them and, when they are being inspected, the one which is being handled does not cause the next one to vibrate. ... Three hives placed one above the other is plenty, since even then the beekeeper does not inspect the top row with sufficient ease. (IX.7.1-3)

Much of the contents of Chapters 2 to 16 was quoted elsewhere (Crane, 1994), and Section 7.5 here gives Columella's method for finding a natural nest, to collect bees for use in a hive.

Pliny

Pliny the Elder (AD 23-79) was a contemporary of Columella. He tried to extract what was useful from as many books as possible, but in his writings he arranged subjects indiscriminately, including both fact and fiction, and added no new ideas or discoveries. His nephew Pliny the Younger said in a letter to Baebius Macer (III.5) that his uncle was a compulsive writer, always accompanied by two slaves – one to read to him and one to write down anything he considered of note.

Book XI of *Naturalis historia* was largely copied from Aristotle's works. Pliny said almost nothing about beekeeping methods, but he was the only writer in Antiquity known to mention observation hives, 'on the suburban estate of a certain ex-consul in Rome, who had hives made of the transparent horn of a lantern' (XI.16.49). He also made another entry: 'Many too have made hives of transparent stone [mica?], so that they might look on the bees working inside' (XXI.47.80). Pliny's observations using a transparent hive are quoted near the end of Section 52.43.

Pliny's passage on the building and use of combs by bees is a fuller variant of one in Columella's *De re rustica* (IX.15.6-8), and the words I have put in italics show that Roman beekeepers did not know how to get bees to build all their combs across the hive.

> The combs hang firmly attached to the upper part and also a little to the sides at the same time, but they do not reach to the floor of the hive; *sometimes they are oblong and sometimes round, according as the shape of the hive requires, and occasionally also of both kinds,* when two colonies whose members are friendly have different customs. ... The first three rows

or so are arranged empty, so that there may not be any obvious temptation to a thief; the last ones are filled fullest with honey; consequently the combs are taken out from the back of the hive. (XI.10.23-24)

Book XXI of *Naturalis historia* contains two rather similar instructions for adjusting the size of a hive, which are variants of Varro's passage in *Res rusticae* (III.16.18). One reads:

> It is very useful ... for a movable cover to be made at the back [of the hive], that it may be brought forward if the hive be large or the working unproductive, lest the bees lose hope and cease to care; this cover should be gradually slid back so that they do not see how their work has grown. (XXI.47.80)

Section 35.22 quotes a passage by Pliny on transporting hives by boat.

Later writers

Strabo (*c.* 60 BC to AD 21) made the comment that 'there are many beekeeping establishments in Arabia Felix' (XVI.4.2), and referred to several honeys and to beeswax. Seneca (5 BC to AD 65) discussed the production of honey by bees.

Aulus Cornelius Aelian taught in Rome and died about AD 220; he knew Greek so well that he wrote *De natura animalium* in that language. The book presents passages from Greek and other authors as moral tales, and a few of them include notes about beekeeping which contain something new. He discussed ways for getting rid of creatures listed by other Roman authors as harmful to bees: wasps, swallows, serpents, lizards, bee-eaters and frogs (I.58). He also said: 'Beekeepers can foretell bad weather from the behaviour of bees. Rain and snow do bees more harm than cold, especially if the hives leak' (I.11).

Rutilius Taurus Aemilianus Palladius lived in the 300s, but nothing is known about his life except that he wrote *Opus agriculturae*, a succinct month-by-month account of practical agriculture. The beekeeping material is copied from authors already discussed – especially Columella – although he does not name them. Section 32.53 mentions a 1420 English translation.

The *Declamations* of Pseudo-Quintilian, written between AD 100 and 400 (Section 24.3) included an emotive description of hive making:

> It gave me pleasure to weave the pliant withies with spring twigs, and to fill the gaping fissures with clinging mud, to prevent either the heat of summer or the cold of winter from penetrating the teeming hive. (XIII.3)

The *Geoponica* was a work on agriculture put together in Constantinople during Byzantine times, and was given its present form in AD 950. It was translated by Owen (1805), and Fraser (1951a) summarized the material on bees and beekeeping. The book claimed to quote many famous Greek and Roman writers, but should not be taken as a reliable guide to them (Crane & Graham, 1985); it is more likely to have referred to Byzantine times. Book XV.2.7-8 gave dimensions of hives, which should be made of boards of beech, pine, fig or oak, 1 cubit wide and 2 cubits long (about 50 x 100 cm).

24.2 Characteristics of beekeeping in the Roman World

Roman writers described beekeeping with which they were familiar, but without indicating where it was practised. Their knowledge extended over a larger area than Rome itself, but clearly not to all the regions under Roman influence when the books were written. Columella and Varro were familiar with parts of Spain, and some of their descriptions probably referred to beekeeping there. On the other hand beekeeping practices in many areas under Roman influence – including Greece – differed from those around Rome but were not described, and may not have been known, by Roman writers. Some knowledge of beekeeping in Carthage had probably been assimilated from the Latin translation of Mago's book (Section 21.5), and *Ferula* hives were mentioned although without any explanation of their special use (Section 22.13). Hives used in the south of Italy around AD 1000 are known from Exultet Rolls (Section 25.21), and some Roman descriptions could apply to similar hives.

All four major Roman writers on beekeeping mentioned hives of plant materials, which were better than those of earth materials: lighter in weight, less breakable, and with more suitable thermal properties; Columella decried earthenware hives. Several writers, for instance Columella (IX.7.2) and Pliny (XI.10.24), made it clear that hives were opened and worked from both the back and the front end. Operations described by one or more authors included: uniting colonies; making new ones by taking and hiving swarms; getting rid of unwanted queens; moving bees 'from one hive into another at the same

place'. Both Varro (III.16.15) and Pliny (XXI.47.80) said that a hive could be made temporarily smaller (shorter) by pushing in its back end closure – an operation which was not common.

The following passage by Columella (IX.15.7-9), similar to one by Pliny quoted in Section 24.1, explained how to harvest honey combs built in different directions within the hive.

> If the hanging waxen cells run lengthwise [built along the hive], the combs must be cut with the iron tool which resembles a knife and must be received by putting your two arms underneath them, and so removed; but if they run crosswise ... then you must use the scraping instrument, so that they may be cut down by the pressure exerted on the side which faces you.

Although the Roman writers used horizontal cylindrical hives, the much earlier technique of fixing combs across such hives and making new colonies apparently never reached Rome.

Like later beekeepers, those in Antiquity loved their bees and wanted to do things for them. Roman writers explained when and how to feed bees and stressed the need to remove filth, vermin and so on from hives; they also described many 'enemies' from which they tried to protect their bees. Beekeeping seems to have been a respected occupation, and the supposed origin of bees a highly honoured one. Beekeeping was also productive: large quantities of honey and wax were mentioned, and different qualities of honey were recognized and kept separate.

Wrong identifications of Roman hives and other vessels

No extant Roman hives are known, but several vessels have been incorrectly published as hives.

Figure 24.2a shows Donaldson's (1827) drawing of a lidded vessel, allegedly of bronze, which he

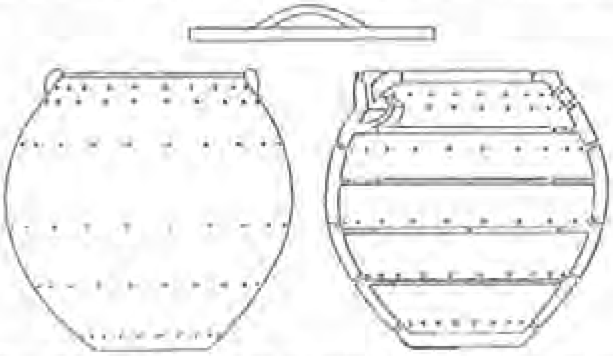


Figure 24.2a Roman jar 48 cm high for fattening dormice, but published as a hive by Donaldson (1827) and many later authors.

described as a hive; it was found at Pompeii, and thus dated before AD 79. Many writers (e.g. Billiard, 1900; White, 1975) reproduced the drawing as that of a hive, although in 1887 Hülsen had shown that it was not. In fact it was a container made for fattening dormice, a Roman gastronomic delicacy (Graham, 1978).

Two supposed representations of Roman hives were discussed by Crane and Graham (1985). One is a Roman funerary plaque from the period between 100 BC and AD 100 which Hülsen (1887) interpreted as depicting two hives with bees being smoked. Amelung (1908) showed that the 'hives' are baskets of fruit or vegetables and the supposed flames are the top growth of root vegetables, but the drawing was again published as a hive by Manino in 1982. The second representation, claimed to be a Roman relief, includes a stylized woven skep, and this was reproduced by Billiard (1900), White (1975) and others as a Roman hive, but Bormann and Henzen (1876) had shown that the drawing was a forgery; it was made during the Rennaissance period.

24.3 The legacy of Ancient Rome to beekeepers during the next 1500 years

The beekeeping described by Roman writers was based on knowledge gained during the previous 2000 years or more in the Mediterranean region. Some of the earlier knowledge these writers preserved was quoted from books by Mago, Aristomachus, Philiscus and others whose texts were subsequently lost. The Roman texts contained written descriptions of beekeeping practices, and the Aristotelian Greek texts on bees survived and were similarly relied on; see also Chapter 52. With their correct observations and their flaws, these Greek and Roman writings reached Islamic Spain (Section 25.31) and were transmitted thence to the rest of Europe; they were the world's mainspring of recorded knowledge on bees and beekeeping until about AD 1600.

A number of types of traditional hives still used in many places in the world are similar to those described by Roman authors (Table 24.1A), and this lack of change – through centuries and even millennia – is characteristic of traditional beekeeping.

Roman laws concerning bees constitute another continuing legacy. In Roman civil law, bees were wild animals, *animalia libera* or *ferae naturae*; they were not tamed or domesticated animals, *mansuetae naturae*. Bees in a hive, however, were the property of the hive's owner, and their unauthorized removal was theft. Bees that flew out from a hive as a swarm

belonged to the beekeeper as long as they remained within his sight. The beekeeper was allowed to go on to a neighbour's land to collect his swarm, although he had to make good any damage done to the neighbour's property. But once the bees were out of the beekeeper's sight they were deemed to have reverted to their original wild state. Gaius (*c.* AD 130-180) included an exposition of the subject in Sections 67 and 68 of the Second Commentary of his *Institutiones*, which Swan (1956) set out as follows.

> Wild beasts, birds and fishes, as soon as they are captured become by natural law the property of the captor, but only continue such, so long as they continue in his power. After breaking away from his custody, they may become the property of the next captor. Their natural liberty is deemed to be recovered when they have escaped from his sight, or (though they continue in his sight) when they are difficult to recapture. In case of those animals, however, which are in the habit of going away and returning, as pigeons, bees and deer, the rule has been handed down that only the cessation of the intention of returning is the termination of ownership; and then the property in them is acquired by the next captor. The intention of returning is held to be lost, when the habit of returning is discontinued.

Roman law was codified by Justinian, the Roman Emperor from AD 527 to 565.

A series of *Declamations* falsely ascribed to Quintilian,* a celebrated jurist and law tutor, included various hypothetical exercises for his students. The 13th Declaration, 'The case of the poor man's bees', included a speech in which the poor beekeeper states his case against his wealthy neighbour who – resenting the bees' encroachment upon his orchard – had sprinkled a deadly drug on all the flowers of his fruit trees, thereby killing the bees. There was no record of the Defendant's speech, nor any indication of what the Judge's decision should be.

Gaius's exposition of the law on swarm ownership (above) was and often still is the basis of rulings in many countries whose law belongs to the Romano-Germanic family: for instance, Austria, Bulgaria, Czechoslovakia, Finland, France, Germany, Italy, Portugal, Sweden and Switzerland. The first sentence of the 1734 Swedish law – which is still valid – reads: 'Should bees fly to another man's forest and the owner follows them to tree and hole [which they occupy], marks the tree and notifies the village council, no one can deny him his rights.' In Spain, Argentina and Chile, the right to follow a swarm has been limited to uncultivated and unhedged land (Frimston, 1966). Brazil has a detailed law, set out by Apiário (1977). Developments of these and other laws affecting beekeepers in different countries were discussed in some detail by Crane (1990a).

*The author, known as Pseudo-Quintilian, lived some time between AD 100 and 400.

24.4 Beekeeping assessment of early traditional practices in the Mediterranean region

The earliest hive beekeeping known, which used horizontal hives, was done in Mediterranean lands and islands (Chapters 20 to 24). In many parts of this region traditional methods were still practised during the 1900s, and they appear to have a close resemblance to those used in Ancient times.

It is useful first to compare hives from pre-Roman times excavated in Spain and Greece (including Aegean islands) with those described by Roman authors, two of whom had lived in Spain (Section 24.1). All known hives were used horizontally, and almost all were roughly cylindrical. The diameter was quoted by Columella as 1 foot [30 cm]; that measured in the 1990s for six of the pre-Roman Spanish hives was between 24 and 29.5 cm (Section 21.7), and the mouth diameter of the nine earliest Greek hives was between 28 and 39 cm (Table 23.2A). The hive length quoted by Columella was 3 feet [90 cm]; that measured for the Spanish hives was 54-59 cm, and for the nine Greek hives was 41-60 cm. The length of hives, but not the diameter, was likely to be greater in later centuries; see Section 23.22.

Columella (*c.* AD 80) referred to horizontal cylindrical hives of cork, woven wicker, wood (log), and earthenware which he regarded as the worst, hot in summer and cold in winter. All but the last are degradable, and would not be expected to survive. In the late 1900s the use of traditional horizontal hives in Spain survived in an enclave in the north (Section 25.6); hives included pottery cylinders embedded in a wall in the Ebro valley, and woven cylinders of wicker or cane under a shelter in Upper Aragon (Figures 32.2a and 32.2k).

Table 24.4A indicates where certain significant beekeeping operations were carried out, some of which were possible only with specific types of hive. In a horizontal hive, bees usually store honey at the back, farthest from the flight entrance and thus well protected from marauders. So honey combs were har-

vested from the back if the hive could be opened there (column A): the bees were driven by smoke from the back on to brood combs near the front of the hive, and sometimes out of the flight entrance. In hives opened at the front, harvesting was less easy.

Three separate developments are identified in Table 24.4A.

Column B. The addition of an extension to the hive for the honey flow was widespread: at the back in Crete in Byzantine times, at the front in Ancient mainland Greece and Aegean islands. The bees stored honey in the extension, and this was harvested when full of honey combs. Meanwhile the extra space in the hive would have discouraged swarming.

Column C. 'Yes' indicates that the beekeeper was able to fix combs across the hive at the correct bee spacing, and thus ensure that honey combs harvested from the hive, or from an extension, were round as in Figures 20.3b and 54.3a (or square if the hive had a square cross-section). In the 1900s this was known to be done in Egypt, Crete, Greece, Sicily and Arabia, also by a few peoples in tropical Africa (Section 38.22).

Column D. If combs were built regularly *across* a hive which could be opened from the front, a further traditional technique was developed; it can be seen today, for instance in Egypt and Sicily, and may have been practised more widely in Antiquity. When a colony was rearing queens for swarming, the beekeeper removed a few of the brood combs from the front and fixed them near the front of an empty hive, across it and at the correct bee spacing apart; he added some adult bees and a queen or queen cell, so that a new colony developed in it. This operation also discouraged swarming in the original colony. It was less practicable with hives opening only at the back (see column A) since the bees normally reared brood near the front, and it was probably not possible with conical hives because the comb size varied along the hive.

Roman writers described the use of hives that could be opened at both ends (like those excavated in Spain), but seem to have been unfamiliar with hive

Table 24.4A

Characteristics of Ancient and recent beekeeping with traditional horizontal hives in the Mediterranean region

The front of the hive is the end containing the flight entrance.

A Hive opened from back or front or both.

B Extension known to be added to back or front of hive.

C Beekeeper got all combs built *across* the hive.

D Beekeeper fixed combs of brood in an empty hive to make a new colony.

E Shape of hive; 'cylindrical' includes tapered hives and those with a rounded closed end.

	A	*B*	*C*	*D*	*E*
Egypt: Ancient	?both	no	?yes	?yes	cylindrical
recent	both	no	yes	yes	cylindrical
east of Mediterranean:					
Ancient (none known)					
recent	some both	some	some	some	also other
N Africa: Ancient (surviving records not clear)					
recent	some both	yes	some	some	also other
Cyprus: Ancient*	?both	?no	?no	?no	cylindrical
recent	both	no	no	no	cylindrical
Crete: Ancient*	back	back	yes	?	cylindrical
recent	front	no	yes	yes	cylindrical
Greece and Aegean:					
Ancient	front	front	yes	?no	cylindrical
recent	front	?no	yes	?no	cylindrical
Sicily: Ancient	?both	no	?yes	?yes	rectangular
recent	both	no	yes	yes	rectangular
Spain: Ancient	both	no	?	?	cylindrical
recent	both	no	no	no	cylindrical
Rome: Ancient	both	no	no	no	cylindrical
(none recent)					

* Byzantine times (also Roman in Crete)

extensions, known in Greece from the 400s BC. And no Roman writer described how to get combs built across the hive, or how to divide colonies. Romans learned about bees from Greek sources, but I think that they learned much of their beekeeping from Spain and Carthage.

25

Traditional Hive Beekeeping in Europe I. The South

25.1 Factors affecting traditional hive beekeeping in Europe as a whole

Chapters 25, 26 and 27 describe traditional hive beekeeping after classical times, and Chapters 26 and 27 also cite examples from within the Roman period. Except in the Mediterranean region all hives were made of (biodegradable) plant materials, but a few early specimens have been preserved for nearly 2000 years in acid soil or water.

This Chapter deals with southern Europe where, at first, beekeeping continued with horizontal hives fairly similar to those described by Roman writers (Chapter 24). Meanwhile, in the forests of northern Europe another type of beekeeping was developed independently, using upright log hives (Chapter 26), from a tradition of tree beekeeping. In the more open parts of north-western Europe, log hives gave way to skeps which were basket hives placed mouth down (Chapter 27).

About AD 400, by which time beekeeping with upright hives was already established in parts of northern Europe, Slav and Germanic peoples in the north started to invade countries in the south, beyond the mountain ranges that stretch from the Pyrenees in the west, along the Alps and the Balkan mountains, to the Caucasus east of the Black Sea. Southern and northern traditions of hive beekeeping, previously separated by these mountains, slowly began to interact. During subsequent centuries the horizontal hives in the south were largely replaced by upright hives as used in the north, although beekeeping with them was generally more primitive. The change was not universal, and some enclaves of horizontal hives remained in territory otherwise converted to upright hives (Section 25.6).

This Chapter deals with regional types of the earlier horizontal hives and with the change to upright hives. The principles of the subsequent beekeeping are explained in Sections 26.1 (for log and board hives in the north-east) and 27.1 (for wicker and straw skeps in the north-west). The beekeepers belonged to a complicated mosaic of peoples, in territories whose boundaries changed from one century to another; in general present country names are used here. The peoples used a wide variety of languages,* and some countries of eastern Europe are less well covered here than others, owing to language difficulties.

During each succeeding century from the 1500s, beekeeping books were printed in greater numbers, and with more attention to new ideas. But the scientific knowledge which could improve beekeeping grew only slowly (Chapter 52), and often seemed to have rather little impact on traditional methods.

25.2 Traditional beekeeping in Italy

25.21 Southern Italy

For many centuries after the Roman books discussed in Chapter 24 were written, beekeeping in southern Italy continued on the lines these books described. The earliest known illustrations of hives in this region were made between 900 and 1200, in 'Exultet Rolls', manuscripts produced in a number of monasteries south of Rome. *Exultet* is the first word of the hymn of praise to bless the beeswax Paschal (Easter) candle burned by the Roman Christian church on Holy Saturday (Section 54.42). In sixteen surviving Rolls an illustration showed hives, and in four it included the harvesting of honey combs that provided the wax for the Paschal candle. Volume 2 of Avery's book on the Exultet Rolls (1936) reproduced all the paintings in black and white, but her Volume 1 with the commentary was not published. Crane and Graham (1985) included three of the paintings with hives, and details of the contents of all twenty. Hives are always horizontal. Cylindrical hives – probably made from hollow logs or woven plant stems – are in twelve scenes (e.g. Figure 54.4c), and rectangular hives of wooden boards in thirteen, but hives of *Ferula* stems as known from Sicily (Section

*Most European languages are Indo-European, and Le Sage (1974) published a study of words relating to beekeeping, including hive and swarm, in these languages.

22.13) are not shown; perhaps they were not used in Italy itself.

The number of hives in a picture varies from one to twelve, but may have been limited by a desire to include also flying and swarming bees, flowers, and human activity. The scene in an Exultet Roll now in Pisa (Avery Plate XCIV) is similar in several ways to Figure 20.3b from 1450 BC in Egypt. A kneeling beekeeper holds a smoker in one hand and, with the other, is taking honey combs from one of three horizontal hives, and piling them into a stemmed vessel.

Naso (1989) included some items on the circumstances of beekeeping in the south of Italy during part of the 1000s and 1100s when it was a Norman kingdom. In the 900s hives at a monastery near Melicucci in Calabria were destroyed by a female bear; soon after 1000, hives were recorded at the monastery of San Basilio in Lucarna. An inventory of ecclesiastical property in Apulia in the 1200s mentioned two hives of bees in 'domo S. Marine de Grasso', and eight in the monastery of Nicolai do Fazonella. In the 1300s and 1400s (and also later, see Section 22.13) there was much beekeeping in Sicily, especially the west and south-east, and the State Archives of Palermo include two contracts relating to bees. One was made in 1296 between members of the Teutonic Order and a miller employed to run a farm in the region of Salauri which had an apiary of 130 hives. The other, in 1445, was between one man who bought an apiary of 125 hives and another who was to do the work in the apiary for the next 12 years. So some beekeeping was on a fairly large scale.

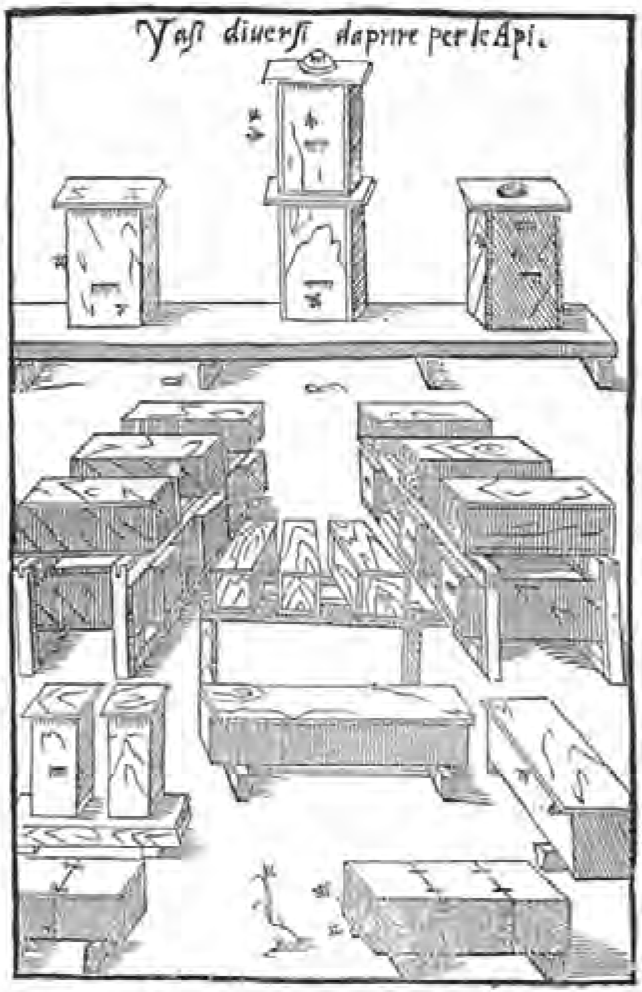


Figure 25.2a Upright and horizontal Italian hives made of wooden boards, some with extensions, on their stands (Gallo, 1596).

25.22 Northern Italy

Invaders from north of the Alps included the Visigoths in 401, Ostrogoths in 489 and Lombards in 568, but during the next thousand years most hives recorded were still horizontal, not upright as in northern Europe. In the book on agriculture (*Opus ruralium commodorum*) by Petrus de Crescentiis, born in Bologna in 1233, Books IX and XIII referred to beekeeping much as earlier Roman books did (Martini, 1968). One of the editions printed in the 1500s shows the portico of a house 'with bees flying in and out of round hives that have been sunk into the walls' (Fraser, 1951a). An Italian book by Fabriano, on agriculture as treated by various authors (Venice, 1557), was probably translated from Herrera's Spanish book first printed in 1513 (Section 25.31). It said that pottery hives should be used where summers were hot, and described a hive 'with two mouths' in which any gaps were sealed with clay. Gallo (1596, see below) also described horizontal hives, cylinders of cork or log, 20-22 *once* long (51-56 cm) or at least 16, and 5 *once* wide; they were to be laid with the front end (containing several entrance holes) to the south. To Gallo, the best hive of all was a horizontal rectangular one of wooden boards which could be opened at the back to take out pieces of comb. Figure 25.2a shows his board hives.

Upright board hives also came into use, and are shown in some manuscript copies of Virgil's *Georgics* (see for instance Figure 33.4b from about 1450). Editions of the herbal by Dioscorides printed in Italy by Matthioli in 1563, 1570 and 1621 also show them. Details about beekeeping with these hives were included in the book on agriculture published in 1596 by Gallo who lived in Brescia near Verona. He described upright hives of many types. Wicker skeps were coated with dung. Cork and log hives were open

at the bottom and had a removable top cover; a knife was used to detach combs at the top, and the hive was inverted after harvesting so that the bees would build comb in the empty space now at the bottom. Upright board hives as shown in Figure 25.2a were opened by removing one side.

A book by Tanaro, printed in Bologna in 1644 and in Venice in 1674, described the 'bad, barbaric way' used by beekeepers in Bologna to harvest honey from upright hives. Hives were put near to a fire of dung and straw, so that the bees in them were killed. Combs were cut out after removing the cover, and put into a basket for sale, or alternatively the whole hive was sold with the honey in it. Tanaro expressed the hope that one day these beekeepers would change back to the old system (with horizontal hives) still used in other parts of Italy, in which the honey was taken without killing the bees; Muratori (1749) also referred to these hives.

Amoretti considered that 'modern' beekeeping started in Lombardy in 1788 when he published a beekeeping instruction manual for the region. His 1811 book included rather stylized drawings of both horizontal and upright hives. He berated local farmers in the Modena area because they were lazy – and used upright log hives – in contrast to beekeepers in Puglia (Apulia) in south Italy, Sicily, Corsica and Turkey, who were able to inspect their (horizontal) hives and so knew when to harvest honey and when not to do so, as the Ancient Greeks and Romans did.

In recent centuries, upright hives of wooden boards were used throughout mainland Italy, and in some Alpine valleys in the north there were various other upright hives: logs, wooden barrels and coiled-straw skeps like those in northern Europe. Armbruster (1926, 1928) discussed these hives and illustrated many examples. The different hives used in the Piedmont area appeared in a book published by Associazione Museo dell'Agricoltura del Piemonte in 1982, and a wide variety can be seen in Italian beekeeping museums (Appendix 2).

Through the centuries, efforts were made not only to improve beekeeping but also, for economic reasons, not to kill the bees. In 1546 the Duke of Piacenza and Parma (north-west of Bologna in the Po valley) had made two proclamations which prohibited the killing of bees for two years, and ruled that swarms were to be sold to persons who needed them. They also ordered the planting of mulberry trees for feeding silkworms, and in 1547 and 1548 defaulters were allowed to use swarms of bees as payment for fines (Casella, 1988). Perhaps individuals who reared silkworms were likely to keep bees as well. Gallo (1596) mentioned a penalty for destroying a swarm imposed in the city of Ascoli. In the early 1800s, during the war against Napoleon, the killing of bees was forbidden in Tuscany (Savani, 1811), and it was the lack of cane sugar that led Amoretti to publish his 1811 book to improve beekeeping and increase honey production.

25.3 Traditional beekeeping in the Iberian peninsula

25.31 Spain

Hive beekeeping existed in eastern Spain before Roman times (Section 21.7), and traditional beekeeping with pottery hives which survives in the Ebro valley, Upper Aragon and some other areas (Section 25.6) shows striking similarities to that described by Roman writers.

Visigoths

Beekeeping in Spain continued after the Visigoth invasion in 507, and a law dating back to King Eurico (466-485) remained in force under the Visigoths until the reign of Leovigild (568-586); see Jaime Gomez & Loren de Jaime (1958/59). The Spanish text is not very clear, but its meaning is something like this. 'Anyone who finds bees [swarms] that do not belong to him, in his own mountain, rock or tree, may set out three empty hives, but these must not be baited [*faga tres corchos que por el uno no poda facer engaño*]. If he disobeys this law, he must pay twice the value of the bees to the person who is thereby deprived of them, and receive ten lashes of the whip.'

Two laws of Sisenando (631-636) stated the restitution to be made by a beekeeper if his bees killed a domestic animal owned by someone else, and also the punishment for a man (whether free or slave) who was found in another person's apiary; even if he had stolen nothing, he was to receive between 20 to 100 lashes of a whip according to circumstances, or even to face death.

Muslims

About AD 700 Muslim Arabs in North Africa conquered Morocco, and in 711 they crossed into Spain; they eventually conquered most of it, as well as what is now Portugal, and the Moorish occupation did not end until 1492. During the intervening centuries Arab scholars in Spain preserved knowledge and beliefs about bees and beekeeping from Ancient Greece and Rome, and themselves added to this knowledge.

Further, through these Arab scholars the knowledge was passed on to the rest of Europe. Texts of important Arabic writers on bees and beekeeping between the 900s and 1100s, discussed by Monferrer (1991), include the following.

980-1037	Avicenna or Ibn Sina, born near Bokhara in Uzbekhistan, and died in Persia
born 1008	Ibn Wafid of Toledo, who studied in Córdoba
1000s	Abu Zacaria
died 1100s	Ibn-al-Awam of Seville
1126-1198	Averroës or Ibn Ruoshd, born in Córdoba

Avicenna translated some of Aristotle's works, and corrected one point: cells prepared for the rearing of 'kings' are larger (not smaller as Aristotle said) than cells for rearing common bees. He quoted Pliny's remark (XI.16.49) about a hive of transparent horn, and also two statements by Hadj of Granada: it is advantageous not to have many males in a hive, and sometimes the females expel or kill the males. Ibn Wafid's book on agriculture was a main source for Abu Zacaria's, translated by J. Banquera as *Libro de agricultura* (1802). Averroës, the most famous of the Arab philosophers, also translated some of Aristotle's works into Arabic, and Latin translations of these Arabic texts were the source of widely disseminated mediaeval manuscripts.

Ibn-al-Awam's book on agriculture, written in the 1100s,* had a more substantial section on beekeeping and quoted in some detail from Aristotle's text, although in places this was greatly altered; he also referred to other Greek writers and the Arabic writers Avicenna, Hadj of Granada and Kassianus. The following are some of his more noteworthy statements. The smallest bees in the hive are females which have a sting; the larger ones are males which have no sting and take no part in preparing honey; the kings are less numerous, and are twice as large as bees that make honey. The bees cling to cells containing honey in order to incubate it. If they did not do so the comb would putrefy, but if they persist with its incubation the honey will keep for a long time, and will not spoil. If several kings are found in a hive the bees become agitated; all the kings must be destroyed except one, selected from among the strongest; his wings are to be clipped with scissors, because so long as the king remains in the hive the bees do not leave it.

Ibn-al-Awam listed types of (horizontal) hive: of cork bark (70 cm long); of resinous wood, pine or larch; of *Ferula* with a square shape; of 'clay of good aroma'; baskets of the same shape as cork hives (woven cylinders), coated with cow dung and ashes mixed with water. His section on bees and beekeeping finished with 'what we are taught by some Spaniards of modern times' (the 1100s), but little of this was new. A swarm issues only from a strong colony, and the date of issue varies much from year to year according to the weather and the bee forage. A swarm usually forms a cluster round its king, resembling a fir cone or a bunch of grapes, but if it settles on the ground, the overseer can more easily 'take' it in a basket. He said that a swarm should not be hived until evening, and described in detail what should be done to ensure that the swarm then remained in the hive.

*The Arabic text was translated into French by Clement-Mullet (1864), and the beekeeping part was summarized briefly in English (*Bee World*, 1932).

Christians

The north of Spain remained Christian during the Muslim period, and Figure 25.3a shows one of six scenes in an illuminated manuscript, *Hymns to the Virgin*, written in Galician during or before the 1200s. This told the story of a villein who, during Mass, stole the consecrated Host (wafer) in his mouth and hid it in a hive. When he opened the hive later, the Virgin and Child appeared in it and did not disappear until Mass had been celebrated with the hive standing on the altar in the church, in the presence of a large congregation. Upright log or cork hives are depicted – some with their lids lifted up – juxtaposed in a row on the ground, with many bees flying around them.

Printed books

The contents of early printed Spanish books, including the following, suggest that Spain had more knowledge about bees and beekeeping than other European countries at that time. Jaime Gomez and Loren de Jaime (1958/59, 1961) gave a full account of the books.

- 1513 Herrera, G.A. de *Obra de agricultura compilado de diversos autores*
- 1586 Méndez de Torres, L. *Tractado breve de la cultivacion y cura de las colmenas*
- 1621 Gil, J. *Perfecta y curiosa declaración de ... las colmenas bien administradas ...*
- 1720 Liger, L.; Torre, D.F. de la *Economía general de la casa de campo* ... (Bees, pp. 167-310)

Herrera (1513) treated bees in his Volume 3, quoting and commenting on Greek, Roman and Arabic

Figure 25.3a The third of six scenes from a Galician manuscript *Hymns to the Virgin*, late 1200s or earlier, in the Library of El Escorial, Spain. The beekeeper, and perhaps his wife, discovering the Virgin and Child in a hive in which he had hidden the consecrated Host.

Figure 25.3b Woodcut showing a Spanish beekeeper in his apiary of cork hives (Méndez de Torres, 1586).

authors, but without criticism or useful new observations. Fr Melífero (1967) quoted part of Chapter 88.

The book by Luis Méndez de Torres in 1586 is important in that it was the first to publish the true interpretation of the queen's function in the colony: laying all the eggs, which develop into queens, drones or workers according to the cells in which they are laid (Section 52.61). The author described what he had seen 'by the sight of his own eyes', but he also repeated many misstatements of Ancient writers, for instance that the queen does not mate. He showed upright hives (Figure 25.3b), and said that the best were of cork but that others were made from boards, or wicker, or cane well plastered. His instructions for beekeeping were practical and based on Spanish conditions. Swarms are to be expected when queen cells are seen at the bottom of combs, either sealed or containing an egg. Unwanted cells should be destroyed by pushing them with a long rod. The queen that goes out with the prime (first) swarm is the *madre* (the one heading the colony). So the wings of each queen heading a colony should be clipped to prevent her flying off later with a swarm. In January or afterwards, according to district, hives are upturned so that brood can be looked for, and left inverted (as in Northern Italy, p. 214). The times of the two or three honey harvests each year are given, and the beekeeper is told to get a professional to bring the necessary knives and other tools – which should be sharp – and take combs from the hives. If an unskilled person does it, many bees may be killed including the queen. The book was discussed in some detail by Fraser (1957a), Armbruster (1961a) and Weickert (1961).

Jaime Gil was born near Zaragoza in the Ebro valley. His 1621 book gave a fuller account of traditional Spanish beekeeping, and described the use of both a horizontal hive (*jacentes*, lying down) and an upright one (*peón*, foot soldier), which were shown in the same apiary. It also described *yetos*, bait hives smeared inside with honey to attract swarms.

The book by Liger and Torre (1720) was the first volume of three that were to comprise a Spanish version 'considerably augmented' of *Maison rustique*, itself translated from *Praedium rusticum* by Charles Estienne (1554). It described beekeeping in Spain between the 1500s and early 1700s – much based on the books by Herrera and Gil – and also showed an apiary with both types of hive (Figure 25.3c).

In 1961 there were still about 400,000 traditional hives in Spain as well as 800,000 with movable frames (Crane, 1961). Horizontal hives survived in a few areas (Section 25.6), but most hives were upright, of cork, usually round but sometimes square as in Figure 25.3d, and managed in much the same way as upright logs. However, some beekeepers made 'forced swarms' by inverting a hive and driving bees into an empty hive placed above it until two-thirds of them, including the queen, had gone up

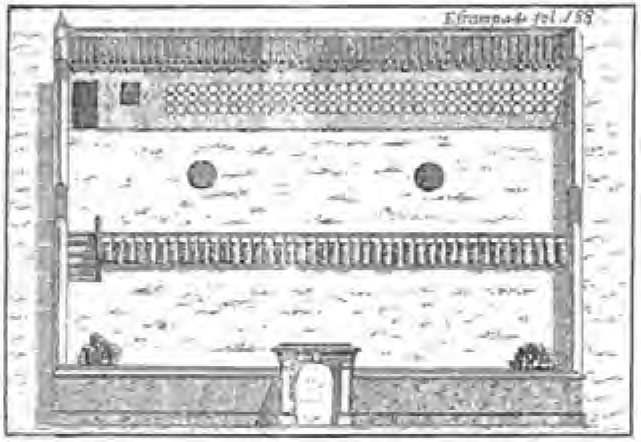


Figure 25.3c Engraving of a Spanish apiary containing both upright and horizontal cylindrical hives (Liger & Torre, 1720).

(Amorim, 1919). In spring 1960, in mountains outside Madrid, I watched a Spanish beekeeping class being taught how to do this driving, by beating rhythmically on the sides of the inverted hive with a stick or stone. The beating was accompanied by shouts used to urge donkeys to move faster. Section 27.12 explains the operation of driving bees from one skep to another.

At the western end of the Pyrenees, Basque people had a long tradition of beekeeping, with a wide variety of hives (Kintana, 1988; Cervello, 1991). In Karrauzo, log hives were stood upright close together in a row, with a continuous cover of schist slabs. Woven skeps in Navarra had a flat wooden top, and were heavily coated with clay and cow dung. Coiled-straw skeps were used in Esquiños, and the type for taking a swarm (Figure 25.3e) could be held either way up by a central handle which extended from the bottom to some distance above the top. Horizontal

Figure 25.3d Hives made from flattened pieces of cork pegged together, Cota Doñana, Spain, 1973 (photo: R. Verhagen).

Figure 25.3e Basque skeps of coiled straw used for taking swarms, Esquiños, Spain (photo: A. Cervello). See text for details.

hives were used in Biskaia and Orozko: thick logs, with the front end open like some in Sicily, and board hives.

25.32 Portugal

Portugal became a separate monarchy in 1139, and Amorim (1919) mentioned 'protective measures and rules of the [beekeeping] industry, engraved in legal diplomas promulgated during the reigns of the earliest kings'. A thesis by Silbert (summarized by Correia Paixão, 1967) gave details of beekeeping from the 1300s. The land was divided into *malhadas*, each a 1500-ha area reckoned to cover the foraging range of bees from hives in one place. The word *malhada* is that for a throw at quoits, and a 1500-ha circle would have a radius of 2.2 km. In 1368 400 hives were allowed per *malhada*, and in 1890 between 764 and 2822. The privilege of placing hives in a *malhada* lasted for 540 years, and seems to have been confined to a landowning aristocracy. But from the end of the 1600s more and more of the land was brought under cultivation, and much bee forage was destroyed; beekeeping no longer flourished, although certain mountain regions still had much bee forage until 1900. The *malhada* system finally ceased during the 1900s when new land laws were introduced. A law code of 1738 had prohibited the placing of hives near urban areas.

Upright hives of cork bark were used throughout Portugal. A piece of cork of the length required (usually about 50 to 60 cm) was cut from a tree – which

then developed new bark – and was overlapped where the vertical slit had been made; the hive diameter was governed by that of the tree. Wooden pegs were used to secure this join and to attach a flat round cork cover at the top. The hive often stood on a stone base, and a notch was cut in the lower edge to provide a flight entrance. Square-cut hives as in Figure 25.3d were more common than in Spain.

Beekeeping was still generally described as primitive in the early 1900s. Many beekeepers were content to watch hives for the issue of swarms and to collect and hive these, but some made 'forced swarms' by driving bees into an empty hive.

According to Mitchell (1919b) beekeepers were then still satisfied with the ancient methods, which yielded only about 5 kg of honey a year from each hive, and (1919a) at harvest time 'the *abelhiero* comes round to the different apiaries, provided with a long curved sharp iron with which he cuts [the combs] half way down from the top, leaving the rest for the bees to winter on'. The *abelhiero* would have been a successor to the professional recommended by Méndez de Torres in Spain in 1586.

In 1961 Cassola de Sousa reported a hive density of 5.2 per km^2, with three-quarters of the hives still traditional. Nearly a third of Moreira's 1968 volume on practical beekeeping was taken up with *apicultura fixista*, using upright cork and box hives. Subsequent modernization reduced the hive density to 3.7 in 1971 (Dias, 1989) and 2.2 in 1984.

25.33 Atlantic islands: Canaries, Madeira, Azores

These islands are too distant from Europe or Africa to have had indigenous honey bees; their beekeeping, and almost certainly the bees used for it, originated in the Iberian peninsula. Enzyme analyses on honey bees in the Canaries (Cornuet, 1990) suggest that the dark bees there originated in the north of Spain. Italian bees were imported in recent times.

Hives of bees could have been taken by early voyagers. The Canary islands, which are only 100 km from the African coast, were known to Phoenicians and other early Mediterranean peoples. Arab navigators visited them in the 1100s, then Genoese, and Portuguese in 1341; the Spanish claimed them in the 1400s and have held them ever since. European voyagers called the people they found in Tenerife – who were probably of Berber ancestry – Guanches, from the earlier name of the island. The first known reference to the presence of honey bees was in 1454 when a sailor, Cademoste, reported that honey was very abundant in Tenerife, as well as wax; he said that the Guanches mixed honey with their staple food of *gofio*, roasted barley (Lefébure, 1905). Figure 25.3a shows hives in the Iberian peninsula in the 1200s, and bees might have been taken to Atlantic islands in such hives.

In 1975 Berkeley found that about 90% of the hives were then (upright) traditional ones, mostly cork cylinders or hollowed palm logs 75-100 cm high, each standing on a flat stone or on the ground; the flight entrance was half way up. Cross-sticks were inserted to support the combs, and honey combs were harvested from the top. The bees were very dark, and 'very irritable'. In Gran Canaria (Clauss, 1983b), the bees were very dark but docile, and there were still wild colonies in the mountains. Most hives were of hollowed palm trunks about 130 cm high, as in Figure 25.3f. In 1989 S. Borneck saw upright hives in La Palma and Gomera, but in Hierro the hives – mainly logs from palm or *pitera*, a cactus – were placed horizontally, and beekeepers did not know that hives could be put upright.

Madeira and Porto Santo, farther out in the Atlantic, were probably known to the Romans but were uninhabited when Zarco from Portugal first sighted them in 1418. Portuguese settled on both islands in 1420, and it seems likely that bees were taken there from Portugal soon afterwards. In 1425 Prince Henry the Navigator sent sugar cane to Madeira from Sicily, and by 1452 a sugar industry was established; after his death in 1460 his nephew arranged the first shipments of wood, wax, sugar and honey from Madeira to Lisbon (Salter, 1956). If the wax and honey were produced in Madeira, the bees must have increased quite quickly. In 1470 prospects for honey production were discussed because of the high price of sugar in European markets (Cassola de Sousa,

Figure 25.3f Hives of hollowed palm logs, with carefully hewn (older) stone covers, Ayacata, Tojeda, Gran Canaria (photo: B. Clauss).

1989), but Madeira was subsequently used to produce *mel de cana* from sugar cane, rather than *mel da abelha* from bees. Traditional hives seen recently (Svensson, 1989) were upright logs, opened at the top to harvest honey combs. Bees in them were dark, and flew at low temperatures. The import of yellow (Italian) bees from Portugal was still under discussion.

The Azores, which form part of the Mid-Atlantic Ridge, were described by Arab writers in the 1100s. It is possible that Carthaginians settled there around 400-300 BC, but the islands were uninhabited when the Portuguese colonized them in the 1440s. Beekeeping was started in 1554 (Armelin Marques, 1997), the bees probably being taken there from Portugal. In a census quoted by Correia Paixão (1966), most traditional hives were upright cork cylinders, 64% of the total being in S. Miguel. Upright earthenware cylinders were also used (Cassola de Sousa, 1961; Crane, 1983a, Fig. 132), but perhaps only in recent years.

Figure 25.4a Hive (*epistomo kofini*) woven on 6 thick stakes with intermediate thinner ones, 1986 (photo: E. Crane). The hive (with the bees) was purchased from Khalkidiki by a beekeeper in Crete.

25.4 Traditional beekeeping in the Balkan peninsula

The Balkan peninsula as far south as Greece was overrun by northern peoples, including Visigoths in the late 300s, Huns in the 400s and Slavs in the 700s. One minor result was that – we do not know when – upright hives of plant materials such as were used in the north replaced horizontal hives. By the 1900s horizontal hives known from Ancient Greece were hardly used on the mainland, although they survived in certain islands.

Greece

The most common upright hive introduced from the north was a woven skep, *epistomo kofini* (open at the bottom), as in Figure 25.4a. It was used in Macedonia (Adam, 1964/65), and Thrace adjacent to present Bulgaria, where it is now known especially in the Khalkidiki peninsula. A beekeeping connection between Khalkidiki and Serbia from the late 1100s suggests a way in which this type of hive might have come to Greece. Khiliandárion, one of the many monasteries on Mount Athos in Khalkidiki, was founded by the King of Serbia in the late 1100s, and it received large gifts of apiaries in Serbia, from its founder and from successive kings in the 1200s and 1300s.

The hive used in Khalkidiki in the 1900s was a woven skep made from either split reeds or twigs of the chaste tree (*Vitex agnus-castus*, Verbenaceae), and the strong upright stakes projected 5 cm or more beyond the weaving at the bottom. The skep in Figure 25.4a had six stakes protruding, like the mediaeval examples in Figure 27.3a and elsewhere. These hives were stood on a flat surface, and in summer the stakes allowed good ventilation; in winter the gap was sealed with mud to leave only a small flight entrance. The top of the skep incorporated a crownpiece, explained in Section 27.14.

Skeps could not be broken easily, and were comparatively light in weight and easy to transport for migratory beekeeping; a pack animal could carry 12. Before transport, the hive was turned upside down (in which position it travelled), and the mouth closed with a cloth cover to prevent bees escaping; a piece of wire gauze might be inserted in the cover to allow extra ventilation.

An upright hive of wooden boards (*kiverti*) was used in Attica and Boeotia, and in Delphi, up to 1982 or later (Papadopoulo, 1985); Bikos (1994b) published an illustrated account of this beekeeping in east Boeotia in 1934. In many parts of Greece traditional beekeeping survived into the 1900s and, although the number of movable-frame hives increased from 400 to 780,000 between 1903 and 1975, there were still more than 200,000 traditional hives in the 1960s and 1970s (Nicolaidis, 1959; Aperghis, 1965, 1975).

Figure 25.4b Exterior and interior of woven skep, Macedonia, 1993 (photo: A. Harman).

Bulgaria

Many early records of the use and sale of honey, and of trade in beeswax, show that the land that is now Bulgaria was very good bee country (Petkov, 1980). The Greek historian Polybius (c. 205-118 BC), said that the Thracians used honey in their meals, and also sold much honey and wax to the Greeks. Bulgars who occupied the country in the 600s came from the Volga/Kama region, and were probably familiar with tree beekeeping (Section 16.2). The country was converted to Christianity in 865, and the earliest references found to hive beekeeping date from the Christian period when the church needed much beeswax for candles, and villagers might pay tribute in wax. Monastic apiaries were exempt from tax, and monasteries produced candles for sale.

Traditional hives were upright logs or skeps, and Figure 21.4b shows skeps woven on flat stakes by a Bulgarian beekeeper; they have an interesting finial. Some of these skeps were protected by hackles, and others stood in an open-fronted shelter. Nearly half Bulgaria's 450,000 hives were still traditional ones in 1939 (Stateloff, 1940).

Macedonia and Albania

Domaćinović's 1989 maps (Section 9.3) show that, in the part of Macedonia which was in Yugoslavia, logs containing nests of bees were cut off and taken home for use as hives; alternatively, bees were collected to put into a hive. Section 27.14 explains the construction of a woven skep of the type shown in Figure 25.4b. Kulinčević (1959) reported that over 50% of hives were then traditional.

Many writers emphasized the wealth of bee forage in Albania. Until 1923 all hives were traditional: woven skeps, upright logs, and wooden boxes of various shapes (Svoboda, 1953; Dedej, 1992). In 1953, 77% were still traditional and gave on average about 5 kg of honey a year, and movable-frame hives 20 kg. By 1990 most colonies were in modern hives (Woyke, 1991).

Serbia, Croatia and neighbouring regions

Slav peoples moved into the Balkan peninsula, and by the end of the 700s independent Croatian and Serbian kingdoms were taking shape. There was much rich bee country, and hive beekeeping flourished in Serbia, Slovenia and Croatia, especially between the 1100s and 1300s.

Serbia had been converted to Christianity in the 800s, and hive beekeeping then became important to the Christian church and other landowners. Kings presented apiaries (or produce from them) to monasteries, and monasteries also set up their own apiaries. The following mediaeval records are from *Monumenta Serbica* and elsewhere (Bessler, 1886). In the 1100s King Stefan Nemanja presented four large apiaries in Serbia to a Serbian monastery in Greece (see p. 219). In the endowment document of the church at Graszanica, King Stefan Deszanski (1321-1336) laid down that 'whoever has bees must give wax to the church; if he does not, the priest may take it'. King Stefan Duszan (1336-1355) presented to the church of St Michael an apiary at Statina that had several thousand hives, and the apiary boundaries were marked in the church's endowment document; he appointed ten of the most capable beekeepers to look after the hives. King Urosz (1356-1367) prohibited the taking of honey and some other commodities from traders by force. In 1379 King Eudokia decreed that everyone should give the church (in Archiljevica) a tenth of their sheep and of their stocks of bees. Nikolaus Utolica, a large landowner, promised to present 50 litres of beeswax a year to a church for celebrating the Ancient Serbian mass.

There was a flourishing trade between Serbia and Dubrovnik on the Croatian coast during the Middle Ages, and honey and beeswax were important commodities (Kulinčević, 1959, 1992). King Stefan Prvovencani (1195-1228) declared: 'Let it be known that my kingdom has allowed the people of Dubrovnik (Ragusa) on the Dalmatian coast to sell wine without water, and honey according to the price list, and if anyone is found guilty of selling wine that has been watered, or honey above the specified price, his goods are to be confiscated.' King Milutin (1215-1321) decreed that beekeepers should be engaged entirely in beekeeping and not in any other occupation, so beekeeping must have been considered important. In 1280 in Vinodol, Croatia, a fine of 50 pounds was imposed on anyone who stole honey from hives at night. After 1389 Serbia was subject to the Turks, and beekeeping declined.

Traditional hives were probably similar to those used in Yugoslavia in the 1900s.

- Upright skep woven from willow and/or vine stems, 50-75 cm high and 25-40 cm in diameter at the mouth, used widely except in Slovenia.
- Upright hollow log cut from a tree with a bees' nest in it, in Kosovo-Metohija and elsewhere.

Stone hives on the island of Brač are mentioned in Section 38.33. In addition there were horizontal wooden hives in Slovenia and farther west (Section 25.6). Domačinović (1989) described hive beekeeping in the forests of Yugoslavia under the heading *Waldbienenzucht*.

In 1959 Kulinčević found that over 50% of the hives in Bosnia-Hercegovina and Montenegro were still traditional, and 42% of the 740,000 in the whole of Yugoslavia. Swarms, and bees from wild nests, were widely collected for use in hives (Domačinović, 1989).

25.5 Traditional beekeeping north of the Balkan peninsula

Herodotus (485-425 BC) said that 'according to the Thracians, bees possess the entire country the other side of the Ister [Danube], and it is because of the bees that none can travel further than this' (V.10). It is assumed that travellers were stung, and the passage implies that bees were plentiful in part of the Danube plains.

The Scythians settled in the region of the lower Don and Dnieper rivers north-west of the Black Sea, and around AD 200 Aelian (II.53) said that they sold honey combs to Mysians in Anatolia, thus refuting a statement by Herodotus that Scythia was too cold for bees to live in. Dacia, corresponding roughly to present Romania, was a Roman province from AD 106. Amphorae surviving from Roman times marked with a representation of a bee (Figure 46.3c) testify to an early trade in honey. Dacia was overrun by northern people from about 275, and I do not know whether horizontal hives were ever used there. Surviving traditional hives are upright, either logs or made of boards (Armbruster, 1926), or woven skeps as in Figure 25.5a. Bartos (1966, 1970, 1971, 1973) described hive beekeeping from the 1200s onwards.

Honey collection from nests in trees was well developed in lands that were at one time part of Hungary (Gunda, 1968). Hive beekeeping there is known from the 1200s, and is comparatively well documented. Several detailed ethnographical studies recorded what survived into the late 1900s (Gunda, 1971; K. Szabo, 1977; Bathó, 1988a, 1988b; Kotics, 1988). Figure 25.5b shows types of traditional upright hive used in addition to hollow logs – a few of which were carved. Most were skeps, and the weaving of one shown in C started with a crownpiece (Section 27.14); another woven skep had a flat top. There were also coiled-straw skeps, some of which were pear-shaped, much narrower at the top. Many

Figure 25.5a Woven skeps, with a thick coating of mud or clay, at Bran, Transylvania, Romania (photo: E.J. Elphick).

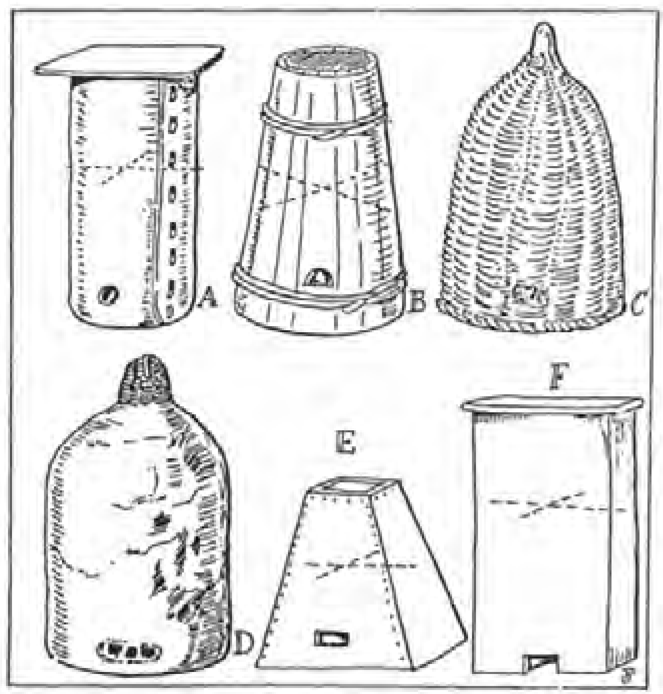


Figure 25.5b Some traditional hives used in Transylvania (Gunda, 1971).
A Bark cylinder
B Made of staves, like a barrel
C Woven wicker skep, from Transylvania
D Similar skep from Komádi, Hungary, probably coated with mud and dung
E 'Pyramidal hive' of wooden boards
F Rectangular hive of wooden boards
Dotted lines indicate cross-sticks inside, to support the combs.

examples of traditional hives can be seen in museum collections (Appendix 2).

The Jászság area south-east of Budapest, which was settled in the early 1200s by nomadic Jászyg people, still has relics from the age of great migrations of peoples, and a study by Bathó (1988b) showed that hives included hollow logs and coiled-straw skeps. Between 1710 and 1766 the number of hives increased from 71 to 1317.

Kotics (1988) found similarities between the beekeeping and the associated folklore in Gomor north of Eger and in a part of Slovakia across the border which was Hungarian until about 1920. Farm inventories and lists of tithes show that there was much beekeeping in the late 1600s. By the early 1900s it was the richer farmers who kept hives, mostly coiled-straw skeps; the poorer people depended much on honey and wax, but obtained them from natural nests. Hives were usually placed on a roofed wooden stand that typically held 10 to 20. Wooden hives were almost never seen in Hungarian villages, and seldom in Slovak ones, although they were common in the Poprad region farther north in Slovakia. Beekeeping was based on catching swarms that issued (Section 27.11).

The Hungarian Kings George Rákóczi I (1630-1648) and II both had their own 'bee-masters', one of whom, Michael Horti, wrote *Tractatus de apibus*. Editions of *Meheszkönyv* by Nagy-Enyed and Klausenburg appeared in 1763, 1768 and 1785. Adami published a book for the German-speaking beekeepers in Wiegand near Bratislava (1773, 1784). About forty books on beekeeping published in Hungary before the 1880s were referred to by Bessler (1886), who quoted records suggesting that in the late 1700s the number of hives per square mile in different regions of Hungary varied from 30 to 460 (12 to 178 per km^2), and the number per thousand inhabitants from 13 to 201.

A 428-page book on the history of beekeeping in Slovakia was published by Mičieta (1969). Until about AD 400, Germanic peoples who occupied what is now Slovak land had many encounters with the Romans who occupied lands to the south, across the Danube. It was said that Roman soldiers taught agricultural practices, including beekeeping, to the inhabitants of occupied territories in order that these peoples could keep the troops supplied with food and honey. But hives in much of Slovakia were very similar to those in Poland to the north (Section 26.22), and some of the many log hives were placed horizontally.

In Ukraine on the Black Sea one of the traditional hives was an upright log, sometimes with a door in the side as in tree beekeeping (Section 16.26). Hove, an English merchant who lived in Poland in the 1600s/1700s, described the hives as birch logs about 6 ft (2 m) high, hollowed out to a height of 5 ft and width of 1 ft. Pieces of thin wood, which could be removed individually, were nailed on the side to form a door, and this contained the flight entrance (Latham, 1955). Section 32.53 describes an early apiary containing such hives. Ukraine has an extremely fertile plain where much corn was grown, but during the 1600s and 1700s beekeeping was the peasants' only source of income from which they could pay taxes imposed by the Russian rulers. Honey and wax, unlike wheat, were always in great demand in European countries, and also in Turkey.

Maramorosch (1974) published a detailed study of traditional beekeeping made in 1938 in an area of south-western Podolia near the Ukraine-Moldovia border; Podolia was ruled by Lithuania and Poland from the Middle Ages, and later by Russia. There were several types of upright traditional hive, probably derived indirectly from tree beekeeping, but by 1938 only a few examples remained. An upright log hive was covered permanently at the top with a wooden board, and honey combs were cut out from the open bottom. If the log for a hive had been hollowed out to leave only a thin wall, it was bound with three double willow rings, as a barrel might be. The flight entrance was in the side. Similar tall hives were made of substitute materials, either wooden boards (square), or coiled straw (round) tapering slightly to the top. Mud or other material was used to coat hives or seal cracks in them, and cross-sticks were inserted to support the combs.

25.6 Enclaves of horizontal hives in regions with upright hives

Between the 1500s and early 1800s both horizontal and upright hives were used in Italy and Spain (Sections 25.22, 25.31). In other countries covered in this Chapter, upright hives had generally replaced horizontal ones, but in the other parts of Europe where hives were usually upright, there were enclaves where horizontal hives remained in use until the late 1900s in the Pyrenees, Alps and Caucasus. Horizontal hives also occurred sporadically in localities in Poland, Denmark and Germany farther north (Sections 26.22, 26.31, 26.21, 27.21).

Around 1990, many horizontal cylindrical hives woven from osiers (willow, *Salix*) or reeds were found in open shelters on the southern slopes of the Pyrenees of Upper Aragon in Spain, but almost all were empty. Similar hives were also found on narrow rock ledges in limestone gorges (Section 32.21). A few metres from some apiaries of either type was a single 'satellite' hive, similarly constructed and placed (Figure 32.2l); it was probably a bait hive for a swarm issuing from one of the main hives. Chevet and Chevet (1987) described these hives and apiaries. In the Ebro valley below this region, apiaries survive with cylindrical pottery hives embedded in three rows in a wall (e.g. Figure 32.2a).

The best documented enclave of horizontal hives is in the southern Alps extending from Slovenia in the east (discussed below), through certain valleys in Italy, as far west as Switzerland; see end of Section 27.23. The beekeeping history of the area within Switzerland was described by Sooder (1952). In Italy, beekeeping with a Roman-type horizontal hive survived into the present century, in a southern subalpine region whose history is the subject of a book by the regional Associazione Museo (1982). This hive of wooden boards is reminiscent of those in Italy around AD 1000 (see p. 212). Armbruster (1928, 1929, 1932b) discussed the hive (*Tunnelstock* or *Bauernkasten*), and Crane (1983a, Fig. 57) reprinted his distribution map.

A third enclave is in the Caucasus mountains that stretch from the Black Sea to the Caspian. The tradition here may have come from areas of the Middle East that are now in Turkey, Iraq and Iran; see Table 21.4A. Phillips (1933) photographed woven horizontal hives stacked in a crude shelter, together with upright log hives without a door. Figure 25.6a shows a variety of empty horizontal and upright hives, including (on the left) a horizontal log whose upper half could be removed when harvesting honey combs;

Figure 25.6a Traditional hives used in the Caucasus (Armbruster, 1926). *centre* Log hive with a door in the side; above it, two miniature hives (skep and horizontal woven hive) used in queen rearing; *left* Horizontal hives, one split log and two woven; *right* At back, woven skep; in front, horizontal hives, one woven and one (standing) of bark.

Crane (1983a, Fig. 45) published a photograph of this type of hive in the Georgian Caucasus.

Particular developments in Slovenia

One type of hive in Slovenia is of special interest because it led to more advanced beekeeping. Slovenia's most famous beekeeper was Anton Janša or Janscha, born in 1734 and the son of a small farmer. Many of his forebears were beekeepers, and were noted for their skill in painting the hive fronts, as described below. In 1766 Anton and two brothers obtained scholarships to an engraving school started in Vienna by Empress Maria Theresa; she also set up the first beekeeping school in Europe, and in 1769 Anton became its beekeeping instructor. In 1770 his position was made permanent by a patent appointing him Imperial and Royal Beekeeper, but he died of typhus in 1773. Janscha used the local Carniolan horizontal hives of wooden boards (79 cm long, 32 or 37 cm wide and 16 cm high; Figure 40.5a). He juxtaposed them in a bee house, and adapted the hive to enable the beekeeper to use the bees' swarming instinct to his own advantage (Section 40.5). Janscha's 1771 book on swarming explained this, and his complete guide to beekeeping was edited after his early death by Münzberg, his student and assistant, and published in 1775. Peter Pavel Glavar (1721-1784) wrote the first beekeeping book in Slovene, much of it an enlarged translation of Janscha's 1771 book, but it was not published until 1976, by Martin Mencej.

The production of ornamental hives has been a

Figure 25.6b Reproduction of a Carniolan hive front from 1869, showing Mary with the crowned Christ-child (Muzeji Radovljiške Občine, 1973).

specialized form of folk art in various areas of the world. In Central Europe it was part of a general fashion for decorative painting on furniture and houses, which displayed their owner's wealth and enabled rich families to differentiate themselves publicly from poor people. The practice was fashionable in Slovenia mainly between 1750 and 1900; at that time Carniola was the only part of Slovenia where beekeeping was sufficiently developed for a beekeeper to pay an artist to decorate the front ends of his hives so that the bee house presented an integrated display, often along the roadside. The custom started in Gorenjska in Upper Carniola, and spread to neighbouring areas including adjacent parts of Austrian Carinthia and Styria (Cevc, 1973). Individual designs were based on secular or religious motifs, and Figure 25.6b shows one example. Many were metaphorical or satirical, and a number of others depicted animals playing human roles. These 'painted hive fronts' became well known through exhibitions and illustrated publications (e.g. Slovenski Etnografski Muzej, 1968; Muzeji Radovljiske Obcine, 1973; Avgustin, 1979; Rivals, 1980).

26

Traditional Hive Beekeeping in Europe II. The Northern Forest Zone

Chapter 26 covers the belt of deciduous forest shown in Figure 16.2a, well to the north of the Mediterranean regions. The typical traditional hive there was an upright log derived from tree beekeeping. A basket (skep) made from plant stems by weaving or coiled work, the typical traditional hive in the less forested land farther west (Chapter 27), was also used in parts of the forest zone.

26.1 Basic details of beekeeping with upright log hives

The main factor that initiated a change from tree beekeeping (Section 16.2) to hive beekeeping in the forested region was a shortage of natural tree cavities, brought about by tree felling on land to be used for agriculture or some other purpose, combined with prohibitions from landowners against the making of new cavities in trees. At first, such a shortage of cavities might be compensated for by fixing separate hollowed logs up trees in the forest, as in Figure 26.1a. Later, the logs were placed together on the ground in an *apiary*, near the beekeeper's dwelling or in some other appropriate place. These changes started at different times in different parts of the region, depending on environmental and social conditions.

26.11 Tree trunks and hollowed logs

A type of hive derived directly from tree beekeeping, referred to here as a trunk hive, was a section of a tree trunk containing a cavity, probably already occupied by bees, which was separated from the tree with an axe or saw. The German word, *Klotzbeute*, was used at least as early as 1514 (Unger, 1954). The wood was solid at both top and bottom, and to get access to the cavity the beekeeper made an upright hole in the side which he provided with a door, as in tree beekeeping. Some of the hives were massive (see for instance Figure 26.2e), and iron bands might be put round them. The top of the hive was usually protected by a flat stone, conical thatch, or some other cover.

A more manageable type of log hive (German *Klotzstülper*, inverted log) was made by hollowing out a section of a smaller-diameter tree trunk, usually from both ends, leaving a thin uniform wall. The hollowed log was placed on a base such as a flat stone or wooden stand. The top was protected by a cover which was often removable so that some honey comb could be harvested there (Section 26.12).

When and where wooden boards were available, a hive could be made from them (Figure 25.5b,F), and managed like a hollowed log. Such hives were about 80 cm high and 30-35 cm across in Poland, and about

Figure 26.1a Log hives supported on branches in trees, Zamosze, Poland (Blank-Weissberg, 1937).

90 cm high and 30 cm across in Öland, southern Sweden (Husberg, 1994).

The flight entrance of any of these hives might be a hole in the side or, if the hive was open at the bottom, a notch or irregular gap between the wood and the hive stand.

26.12 The summer season

In the forest, most flowering occurred during spring and early summer. In large hives colonies were less likely to swarm, and the beekeepers did not necessarily collect swarms (Berner, 1954), although any that issued might settle in empty hives. The beekeeper's work consisted of little more than taking the honey, unless he migrated some of the hollowed logs.

When harvesting honey, smoke was used to pacify the bees and to drive them off the honey combs to be taken. With a trunk hive, honey combs were removed through the access hole after removing the door. A hollowed log closed at the top was tilted up and honey combs were cut out from the bottom. If the top cover could be removed, this was done after breaking or cutting comb attachments to it; honey combs were attached also to the side walls of these relatively narrow logs, and parts of them were cut free and removed, leaving the rest in place. A board hive was dealt with similarly.

Some care was taken in summer to ensure that the colony would survive the winter. The harvest was either taken early enough in the season for the bees to store further honey for their use in winter, or the beekeeper aimed to leave enough honey to last the bees until spring.

26.13 Wintering

Winters are longer and summers shorter in the north of Europe than the south, and at latitudes above about 60°N the winters are so long and the summers so short that honey bee colonies cannot survive (Section 9.5). The length and severity of the winter varied greatly from year to year, and a main hazard of traditional beekeeping at latitudes above about 50°N was the very high death rate of colonies in extreme winters. Some beekeepers provided thermal insulation by packing straw or other plant material in or outside hives, as mentioned in Sections below. In the early period of traditional beekeeping it was not usual to leave food other than combs of honey – indeed nothing appropriate was available, and sugar was then much dearer than honey.

Olaus Magnus Gothus, the last Roman Catholic Archbishop of Uppsala, and Primate of Sweden and Gothland, wrote about the peoples of northern Europe in 1555. Several of his illustrations and comments on beekeeping are included in this book, and Armbruster (1940c) discussed them further. In his Chapter 17, Olaus Magnus regarded it as incorrect to say that 'inhabitants of the northern subpolar shore do not have the use of bees'.

> Cleverly, the northerners know how to keep them through the winter without disease or loss in numbers from the vehement cold. ... In mid-September they envelope all the hives with fibrous stems or reeds. ... If such provision is neglected, many bees will die. Some bees indeed, enclosed in dense timbers and enveloped with pine bark, survive undamaged for almost eight months through the winter and among dense snows.

Some of the comments made by Olaus Magnus are fanciful, but those quoted above (translated by Francis Minns and Stephen Bate) appear to be based on an acquaintance with hive beekeeping in southern Sweden or elsewhere in northern Europe.

26.2 Traditional beekeeping in north-eastern Europe

26.21 Germany east of the Elbe

Figure 16.2a shows how Germany was transected by the boundary between the main areas of tree beekeeping – followed by log hive beekeeping – here and skep beekeeping farther west, although the two systems were not entirely separated by this line. The tree beekeeping (Section 16.25) had developed within its own framework of organization and laws, and the hive beekeeping in the same area was also to some extent organized (Fraser, 1951a).

Two upright log hives preserved in peat bogs in northern Germany have been excavated. The earlier was found in 1970 (Zoller, 1972) at Gristede, 25 km from Oldenburg in north-west Lower Saxony, and is now in the Forschungsstelle für Siedlungsarchäologie in Rastede. When found, the hive lined a well and held pottery dated to AD 100-200, so it would be at least as early as this. It is 1 m high and 31 to 44 cm in diameter; a horizontal slit near the base could have been the flight entrance. The other hive (Figure 26.2a) is dated to AD 400-500; it was found in three parts by Diekmann (1963) in a bog at Vehne-Moor, 25 to 30 km from both Oldenburg and Gristede. The parts were easily reassembled into a cylinder 100 cm

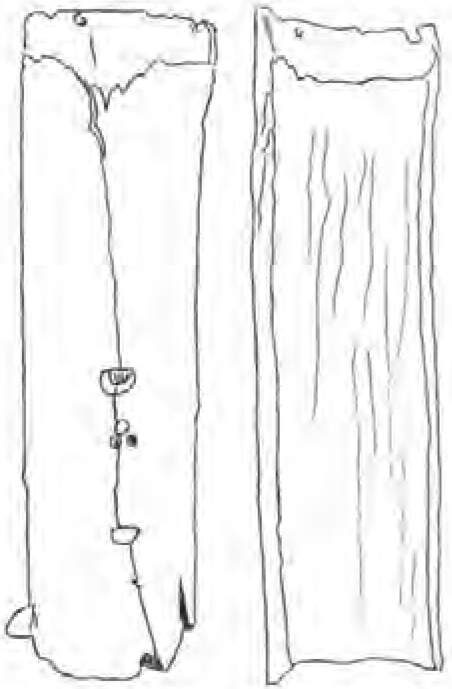


Figure 26.2a Beechwood hive from AD 400 to 500, found at Vehne-Moor, viewed from the front (drawings: H. Diekmann). *left* Reassembled hive; *right* Back, with front removed.

high and 30 cm in diameter, with two flight holes at different levels and a cover fixed on to the top with wooden pegs. Beneath the hive were remains of beeswax comb and of willow rods.

Leges Barborum, Frankish and Germanic laws which date from around the 500s, laid down the punishment for stealing hives of bees in the open or – a more serious offence – from a closed roofed structure (Berner, 1920); perhaps this structure was a forerunner of the German bee house (Section 32.32). In Bavaria, *Leges Bajuvariorum* (744-748) gave detailed instructions about the procedure when a swarm from one man's hive settled on another man's land, and referred to hives of wood, bark and wicker. According to Visigoth law a beekeeper who kept an apiary in a town or village had to move it away if the bees caused damage or disturbance to people or their animals (Guérard, 1836/44). In the 800s an inventory of the Abbey of Staffelsee in Bavaria included 60 geese, 50 chickens and 17 hives, also half a measure of honey (Duby, 1962).

The tithing of trunk hives in 1375 is shown in Figure 26.2b. In 1419 the Berlin heathland was delivered to Heyne Cunes and his brother and their heirs, to establish hives and bees according to the advice of the councillors. The brothers could take wood from the heath to make hives, but they could

Figure 26.2b Log hives being tithed (*Sachsenspiegel*, Meissen, c. 1375; Armbruster, 1938a). Three hives are shown upright, 6 lie horizontally, and one is being handed over as the tithe. All hives have a door in the side, and were probably used upright.

not sell hives or bees except to someone able to continue working with them. They had to give the town half the honey produced each year (Migul, 1965). The woodcut of trunk hives in Figure 26.2c appeared in 1485, in a very early printed book.

In 1568 Nickel Jacob listed poplar, lime, alder and willow – but not oak – as trees from which trunk hives were made. A hive was sometimes used horizontally (*liegende Walze*), and Schier (1939) found sporadic records of this practice in central and eastern Germany from the Baltic to Sudetenland and the Danube. A very large log might be divided internally to house two colonies side by side or, as in Figure 26.2d, one above the other.

Until the 1600s the chief value of the forests was for hunting, and for collecting honey and wax. But during the Thirty Years' War (1618-1648) many trees were felled and bees' nests destroyed, and the use of hives increased: beekeepers cut logs from dying trees and moved them near their houses (Wendorff, 1963).

From the 1600s, especially between Weimar and Breslau (on the Salle and the Oder), the *Figurenstock* was developed from the trunk hive: a large upright

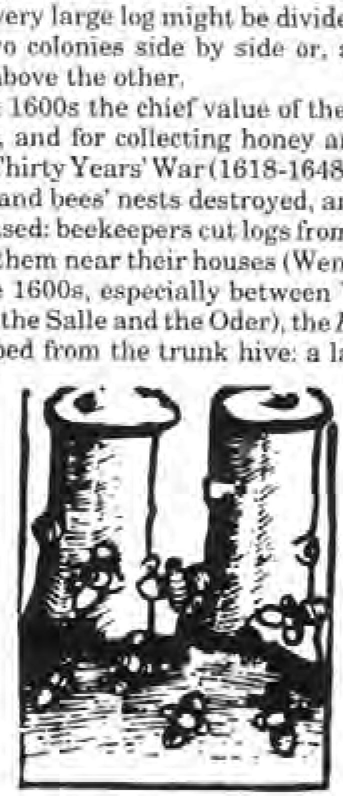


Figure 26.2c Upright trunk hives not showing doors, in *Ortus sanitatus* by Johann von Cobe, printed in 1485 in Augsburg, Mainz and Strasburg.

Figure 26.2d Two hives in one trunk, felled about 1770, Spreewald, near Berlin (photo: Fördererkreis der naturwissenschaftlichen Museen, Berlin).

log with a face, usually human, carved on the surface (Klose, 1925); the ornamentation was further developed by carving the whole log into a human shape. Jung-Hoffmann (1993) illustrated and described a number, and many can be seen in German museums (Appendix 2); Figure 26.2f shows Polish examples.

The first book in German devoted to beekeeping was printed in 1568: *Gründlicher ... Unterricht von Wartung der Bienen* by Nickel Jacob, a burgher of Sprottau in Silesia. Walker (1929) and Wilson (1932) traced later editions of the book including those by Höfler (1614 in Leipzig) and others from 1660 onwards; see also Armbruster (1940a). Jacob's knowledge was in advance of Eldingen's in Saxony in 1578 (Section 27.21). He knew for instance: that a colony with young worker brood could rear a new queen (*Weisel*, which was then assumed to be male); that bees remove drone brood from a hive when conditions become poor; and that when a hive is put in a new place, the bees learn its location by circling in the air above it. He recognized the existence of a disease [American foul brood] which could be cured by cutting out all comb, starving the colony for three days, and then transferring it to a new clean hive placed in the position of the old one. If bees started robbing from other hives, Jacob sprinkled flour and water on the robber bees so that he could discover which hive they came from. He made queen cages from wood and wire, and was perhaps the first beekeeper to do so. To take bees from a hollow tree, he cut a large hole so that he could remove the combs and the bees on them; he then looked for the queen, caged it, and released it in a hive with the combs and bees. If he did not find the queen, he gave the bees brood comb from another colony so that they could rear a new one.

Jacob gave the external dimensions of a log hive as about 165 cm high and 60 cm in diameter. The cavity might be 105 cm high at the front and 90 cm at the back, and the access hole 40 cm high and 30 cm wide. Jung-Hoffmann (1990, 1993) measured some of the hives in the Armbruster Collection; they were 150-200 cm high and *c.* 60 cm in diameter, made from logs of poplar, lime, willow, oak, alder, beech, sycamore, pine and spruce/fir. Many types of German trunk and log hives were also described and illustrated by Armbruster (e.g. 1926, 1940c) and Berner (1954).

Another important early book from eastern Germany was *Ein neu Bienen-Büchel* by Martin John, printed in 1684 in Lauban south of Görlitz. He dealt systematically with beekeeping through the year, and included chapters on bee diseases and enemies; he was the first to report seeing beeswax scales on the worker abdomen (Section 52.42).

26.22 Polish and Czech lands

According to Bessler (1886), hive beekeeping in Poland is known from around 900. Prince Piast then kept bees in an apiary near Kruschwitz (Kruszwieca) south of Gdansk; he worked there himself, and probably made mead for his guests. In 1145 another Polish prince used the profits from his heather beekeeping to found a monastery, and in 1386 a statute of Janusz I mentioned the overseer of a farm's apiaries. Figure 26.2e shows honey harvesting from an apiary of upright logs in 1542.

The boundaries of Poland expanded and contracted through the centuries, and at its widest extent in 1569 the country reached to the Black Sea, and almost from Berlin to Rostov. So there could have been many interactions between beekeepers who used different methods, over a wide area. Silesia, in

Figure 26.2e Polish beekeeper wearing a protective hood, taking combs from a log hive through the door in its side, 1542 (reproduced from *Pszczelarstwo* 12(8): 245, 1961). The hive is one of six that stand close together, apparently on a base of smaller logs. Combs already harvested are in a shallow wooden dish such as is still common in Poland today. The beekeeper is holding a smoker or torch.

the basin of the upper Oder, was the area where Nickel Jacob (1568) and, later, Johannes Dzierzon lived and worked. At different periods it was under Polish, German or Bohemian rule, or independent, and it reverted from Germany to Poland after the Second World War.

In most parts of Poland traditional hives were derived directly from tree beekeeping, which continued to flourish until recent times (Section 16.23). A log hive usually came from the upright trunk of a living tree, and might be placed on stone (or on wood, as in Figure 26.2e), or directly on the ground, sometimes with a hollow below into which the bees extended their combs (Chmielowski, 1775). A log cut from a wind-blown prostrate tree was used horizontally; some hives were sloped at 45°, and this was also done in other countries. Wolski (1960) described and illustrated many examples of hives, and cited publications on traditional hive beekeeping in different parts of Poland. He believed that the horizontal log hive there could have followed the same course of development as the upright hive. Blank-Weissberg (1937) also included many photographs of both upright and horizontal hives.

When hives were placed at 45° to the horizontal, a special system of management was used. Combs were harvested from the lower part in the first two years, and the empty space was packed with straw for the winter. But when the upper part had much honey, the combs there were harvested and the hive inverted for the next season (Kostecki & Jelinski, 1979).

Ornamentation of the large upright log hives became a specialized form of folk art in Poland, as in eastern Germany. Most of the designs were anthropomorphic, a huge log being elaborately carved to represent a person or, less often, a bear or other animal. Figure 26.2f shows some examples. The flight entrance might be in the chest, navel or skirt – rarely the mouth – and the beekeeper's access door was usually out of sight at the back. A book by Krajowa Agencja Wydawnicza (1978) included photographs of hives painted in bright colours, and ethnographic and beekeeping museums in many Polish towns (see Appendix 2) have examples of the hives. Somewhat similar ones were also made in Russia, Byelorussia, northern Italy, and what were Czechoslovakia and Yugoslavia.

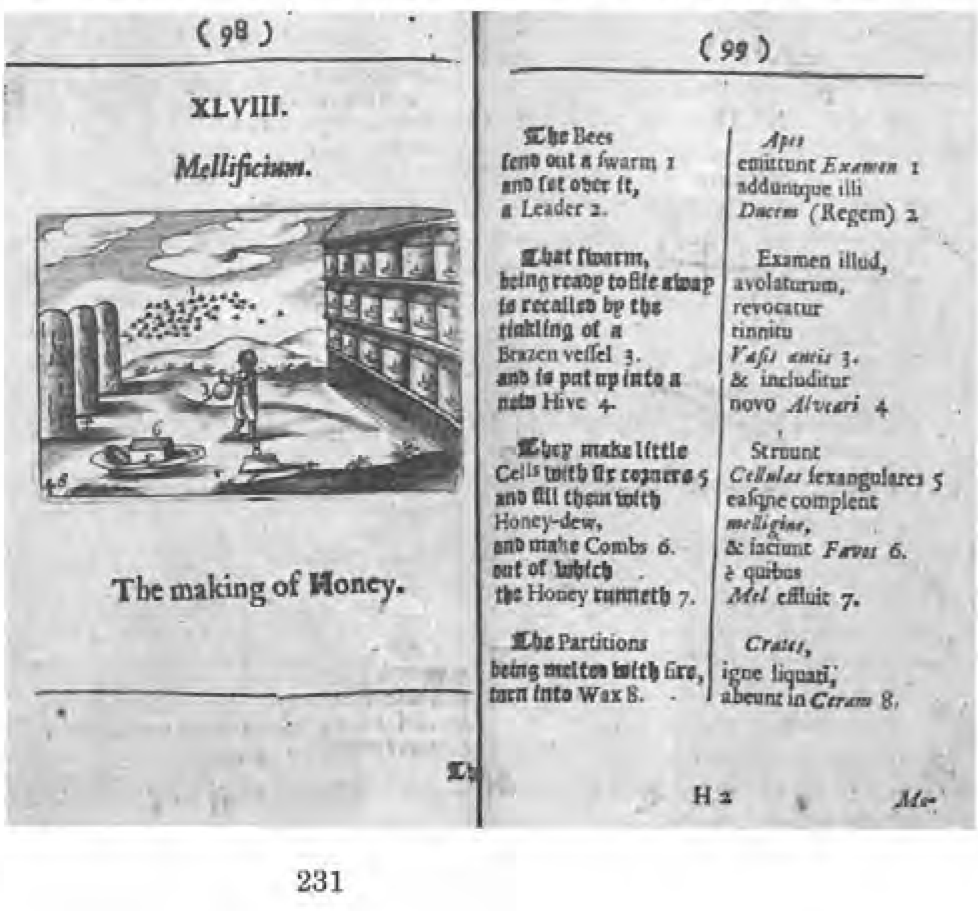
Woven wicker and coiled straw skeps were used in Silesia on the German border – together with log hives – and also farther north in Kashubia in Pomerania (Jelinski, 1987) where a forest law of 1689 in Czluchóu allowed a farmer who found bees in the woods to take them to his farm and keep them.

Most of the present Czech Republic, south of Poland, was in Great Moravia in the 800s. When Bohemia and Moravia as well as Poland were converted to Christianity in the 900s, monasteries depended on the production of honey and wax, at first from tree beekeeping and by the 1000s also from hives. The first clear reference to hive beekeeping dates from 1070, when a foundation deed in Bohemia distinguished between tree beekeeping and garden or house beekeeping – which produced more honey. There is also a reference from the 1100s (Bessler, 1886). Honey had a high value in the Middle Ages, since honey and salt could be exchanged weight for weight. Charles IV ruled Bohemia from 1346 to 1378, and in 1350 he gave landlords exclusive rights over their land for hunting and exploiting bees. Peasants were allowed to keep bees in hives, but had to pay their landlord

Figure 26.2f Some anthropomorphic log hives in the Dzierzon Museum, Kluczbork, Poland (property of National Museum, Wroclaw).

rent: a barrel of honey (about 1.8 litres) and a certain amount of wax for each hive.

Orbis sensualium pictus – the world's earliest picture book for children, written in Hungary – included an illustration of 18 upright log hives in a shelter, and a beekeeper; an annotated key indicated points of interest (Figure 26.2g). It was composed by John Amos Comenius (Komensky) after he was forced to leave Moravia; he was an educational reformer whose parents belonged to the Moravian Brethren.



(98)

XLVIII.

Mellificium.

The making of Honey.

(99)

The Bees send out a swarm 1 and set over it, a Leader 2.	*Apes* emittunt *Examen* 1 adduntque illi *Ducem* (Regem) 2.
That swarm, being ready to flie away is recalled by the tinkling of a Brazen vessel 3. and is put up into a new Hive 4.	Examen illud, avolaturum, revocatur tinnitu *Vasis aenei* 3. & includitur novo *Alveari* 4.
They make little Cells with six corners 5 and fill them with Honey-dew, and make Combs 6. out of which the Honey runneth 7.	Struunt *Cellulas* sexangulares 5 easque complent *melligine*, & faciunt *Favos* 6. è quibus *Mel* effluit 7.
The Partitions being melted with fire, turn into Wax 8.	*Crates*, igne liquati, abeunt in *Ceram* 8.

H 2

Figure 26.2g Child's first lesson about bees and beekeeping, from the Latin-English edition of *Orbis sensualium pictus*, a book by Comenius, first published in 1658.

The book first appeared in 1658, and various editions were published with parallel texts in Latin and another language.

Bohemia and Moravia were ruled by Maria Theresa during part of the 1700s, and their beekeeping benefited from her interest in it. In 1787 a decree authorized steps to increase bee forage: lime trees were to be planted, acacia trees used along roadsides, and heather propagated.

26.23 Russia, including Siberia

Beeswax was supplied to monasteries from the 900s, when Russia first adopted Christianity; it was also paid as tribute (Figure 46.8a) and exported (Section 46.82). Hive beekeeping started in the 1100s (Rozov, 1972) or 1200s (Galton, 1971) – later than in many European countries.

Much of the following information is from Galton (1971). The earliest known written record of hives is from the 1300s, when they were said to be near dwellings and monasteries. In the 1600s they were mentioned as being in trees, on platforms, and in courtyards, but even then tree beekeeping seems to have been more important, and apparently the use of hives did not increase the production of honey and wax.

After the 1521 defeat of the Tatars or Tartars – Turkic peoples of eastern Russia and elsewhere – some of the areas south of Moscow were left unpopulated, and in the 1600s parcels of this land were granted to settlers from other regions, some of whom were beekeepers; in Ryazan province, for example, apiaries were first developed in the 1600s (Mironov, 1969a, 1969b). Upright log hives were first supported in trees and later placed on the ground in apiaries, as elsewhere. Pokorsky-Zhoravko's history of Russian beekeeping (1842) said that apiaries came into more common use under Alexis Mikhaylovich. His code of 1649 laid down the fines for cutting down a tree with a bees' nest in (3 roubles), for stealing hives of bees (3 roubles and punishment by the knout), and for taking bees from a tree (6 roubles) – which would have been of value only to a hive beekeeper. In 1664 the Tsar asked the Governor of Belgorod farther west to send 'from the towns there, 15 or 20 male peasants who could establish apiaries and look after bees'. The lands included bee forests, but these were sparsely populated, and hive beekeeping developed more readily in areas cleared for cultivation, where a common crop was buckwheat (a good source of honey), and fruit orchards were planted.

From the late 1600s both tree beekeeping and hive beekeeping declined, for several reasons. Peasants were taken to the towns to work in new industries. Peter the Great (1682-1725) imposed a tax to be paid in cash on beekeeping income; he also founded the sugar industry, which reduced the demand for honey, and vodka and wine were produced instead of mead. But he himself had an apiary on the Gulf of Finland (Bilash & Krivtzov, 1995), and another at Kilomenskya near Moscow (Foster, 1987). Effects of taxation on beekeeping increased, and in 1704 all towns, administrative areas, landlords and monasteries had to pay taxes on their bees, and in 1709 also on honey from bee trees. All landowners, including the church, had to declare for tax purposes the number of their hives, the annual harvest from each in the years 1704 to 1708, and the number of colonies that died, and why. Taxes might be paid in kind or in money.

John Bell, an Englishman who travelled east from St Petersburg in 1719-1722, described the log hives and where they were sited: 'in proper places, at the side of a wood, and tied to a tree with strong wythes, to prevent their being destroyed by the bears who are great devourers of honey. ... I have seen above an hundred hives near one village; and was informed that they have a method of extracting the honey and wax *without killing the bees* ...' (published 1965). Figure 26.2h, from Kazan in the early 1700s, is an unusual picture from Russia in that it shows a skep, not a log hive. The skep is woven on wide flat stakes, which protrude at the bottom as on some skeps farther south (Figure 25.4a).

Conditions for beekeeping finally improved under Catherine the Great, Empress from 1762 to 1796. She abolished internal custom duties, including those on honey and wax, and in 1775 she freed beekeeping from all taxes: 'Where taxes are still collected on tree beekeeping and apiaries, we remove them and order henceforth that there shall be no collection or payment.'

From the 1770s/80s onwards, hive beekeeping was extended in Siberia, with upright log hives taken from European Russia and Ukraine to Ust-Kamenogorsk and Tomsk. In the 1800s it was spread eastward from there, and Section 36.41 describes both the transport of bees and traditional beekeeping with them.

Bilash and Krivtzov (1995) quoted an 1842 report; there were about 50 million hives in the Russian Empire around 1800, but only 5 to 6 million by the middle of the century. After 1837 beekeeping affairs came under the Ministry of Agriculture and State Lands which gave help of various kinds, and attempts were made to improve methods. From 1845 state aid was provided for agricultural shows, many

of which had a beekeeping section. There were grants for setting up model apiaries, and classes were held in schools and other educational institutions. In 1865 an experimental beekeeping station was established at Ismail; see Mochalkin (1905). Hive beekeeping became widespread in all but forest areas, and the use of log hives continued long after movable-frame hives were common in many other European countries. Figure 26.2i shows an apiary in 1867, and Mochalkin published photographs of log hives in 1905.

The first Russian writings on beekeeping were articles by P.I. Rychkov in 1767, and in the 1770s translations were made of some German publications. P.I. Prokopovich (1775-1850) – the most important and influential Russian beekeeper – devoted the whole of his life to the advancement of beekeeping; see Section 40.6. Before 1962 S.A. Rozov started to write a complete history of Russian beekeeping, but had not completed it when he died in 1965. The unfinished work was published in 1972,

Figure 26.2h Tatar beekeeper from Kazan on the Volga, early 1700s (French copperplate by J. Laroque after J.G. St Sauveur, in Dr August Oetker Collection).

Figure 26.2i Part of 'Rural scene' by A.K. Savrasov, 1867, in the Tretyakov Gallery, Moscow. About 20 log hives stand directly on the ground in a flowering orchard; the beekeeper has just lit his smoker.

and meanwhile Galton's history in English (1971) made many early records more widely available.

26.24 Baltic lands

In lands immediately east of the Baltic, now Estonia, Latvia and Lithuania, hive beekeeping followed on from tree beekeeping which had a very rich tradition in the region, and it was in general similar to that in neighbouring Poland and Russia. Separated logs containing bees were taken home and set upright near the house, and some logs were placed horizontally or sloping, as in Poland. In certain areas tree beekeeping continued until the mid-1800s and was not completely superseded by hive beekeeping until the 1900s. In Estonia, upright log hives fitted with a door in the side were used from the 1500s or earlier, some fixed up trees and others on the ground, and straw skeps were also used. In the early 1800s, a beekeeper in the north might migrate up to 50 log hives and place them up trees near flowering heather.

In a 1782 book in Estonian, Willmann recommended making upright hives of wooden boards, and his 1787 book in German, published in Latvia, was a guide to beekeeping in Lithuania, Estonia and Kur-

land; another beekeeping book in German had already appeared in Latvia in 1769. Where forest trees were several hundred years old, as in Kurland, log hives made from their trunks were very large; species included especially oak, alder, Scots pine and spruce, and hive covers were made from birch or spruce bark.

Traditional beekeeping in Estonia was described by Talts (1971) and Williams *et al.* (1995), in Latvia by Veveris and Kuplais (1986), and in Litau (Lithuania and neighbouring areas including Latvia) by Klose (1925).

26.3 Traditional beekeeping in Scandinavia

Sweden and Norway were united with Denmark under a Danish dynasty from 1397 to 1471, the southern tip of Sweden (Skåne) until 1660, and Norway until 1814 – after which it belonged to Sweden until 1905. Finland was disputed between Sweden and Russia from the 1100s onwards; it became a province of Sweden in 1581, was ceded to Russia in 1809, and proclaimed its independence in 1917.

26.31 Denmark

In the 1200s the Danish *Jordbog* said of the Danes: 'Their drink consisted of Danish ale and mead, ... to obtain mead they applied much to the cultivation of bees' (Wakefield, 1812). Some of the laws of Jutland (1241) and Erik's – probably earlier – laws of Zealand were included in the Danish laws of King Christian V (1683). Several of these were concerned with the placement of hives and the ownership of swarms, and are quoted by Skov (1978).

According to the Danish law of 1683 the owner of bees had to fence them against other people's animals, and he got no compensation if the fence was so low that animals could enter, and they knocked the hives down. The beekeeper had to pay compensation for cattle stung to death if they were inside the apiary because of inadequate fencing, but not if they were outside (V.13.1-3). A man X who followed a swarm from his own hive on to land owned by Y still owned the swarm, and after contacting Y he might take it provided he did not damage the tree where it had settled. Otherwise he had to put an ownership sign on the tree, which remained until Y felled the tree. Then X 'will have the bees and the honey'. Meanwhile if Y (or anyone else) took them, it was theft (V.13.5,8,9). If an owner did not follow his swarm, the first person who found it 'in forest, field or graveyard' became its owner, but could take it only if he did not

Figure 26.3a Danish woodcut showing hives under ridged roofs, and beekeeping equipment (Hervigius, 1649). *top* Upright log hives used in Sweden; horizontal log hives used in Denmark. *centre* Two types of smoker; bees at water supply. *bottom* Four hive tools; a hive carried between two poles; just above, square board with handle, possibly to hang up for a swarm to settle on.

damage the property of the landowner (V.9.6). If a man entered another man's apiary, killed the bees and the *Fører* (cognate with *Führer*, ruler, i.e. queen) and took the honey, then it was vandalism. A 1793 Danish regulation stated that hives might not be placed closer to a road than 10 *Alen* (6.5 m) (Andersen, 1934).

N.M. Aalborg's *Ny husholdnings-Calender* which included *En liden Tractat om Bier* was published in 1639, and *En nyttig Bog om Bier* by J. Hervigius in 1649; Fleischer wrote a book on practical beekeeping in 1777. Hives were logs hollowed out by burning over a fire, and they were placed near the house.

Hervigius included a woodcut showing log hives with a door in the side 'placed horizontally as in Denmark, and upright as in Sweden' (Figure 26.3a), and another log being carried between two poles. In a second woodcut (Figure 34.4a) a swarm clustered on the branch of a tree is being dislodged by smoke produced with the aid of bellows. Horizontal hives now in museums in Gothenberg and Varberg were made by hollowing out a split log and binding it together again, and they have an integral alighting board (Sandklef, 1937). Another horizontal hive (*Liggekube*) was made of coiled straw, like a jar with a narrow neck. As in Poland, the origin of these hives may well be the use of a log containing a bees' nest, cut off a wind-blown prostrate tree. According to Hervigius (1649) hives of wooden boards were also used.

Straw skeps spread into Denmark during the 1600s, presumably from Germany. They completely replaced wooden hives and disappeared only slowly after movable-frame hives were introduced in the early 1860s (Hammer, 1950): they represented 56% of the hives in 1898, but only 7% in 1929. Straw hackles on Danish hives were characteristically tall, and reached down to or beyond the flight entrance. Skep beekeeping survived longest on the island of Rømø off south-west Jutland.

Sandklef's 1937 Swedish book included information on early beekeeping in Denmark.

26.32 Sweden

Hive beekeeping was possible only in the south of Sweden, and the map in Figure 9.5a shows a suggested limit of honey bee survival in the wild in recent times (about 60°N), and also during the warmer postglacial period.

Ansgar arrived in Birka in 829 as the first Christian missionary in Sweden, and his book *Vita Ansgarii* described the country as rich in honey. In 1220 West Gothland laws referred only to bees' nests in trees, but in the late 1200s (Holmbäck & Wessén, 1933) Law 35 in East Gothland prohibited the use of a honey-water mixture to attract bees, and the placing of bait hives near another person's apiary, so hive beekeeping had started there. The owner of a swarm that entered an illicit bait hive could recover it, and the 'thief' was fined 3 marks. The Law also regulated the taking of bees from tree cavities in an owned forest. Laws in Skåne and elsewhere on the ownership of swarms date from the 1300s or earlier, and the laws of 1734 are still valid.

By the 1500s beekeeping was common in eastern parts of southern Sweden, especially in Småland (Husberg, 1994). Hives were upright logs which often had a door in the side, and wooden boxes about 90 cm high and 30 cm across. Swarms were watched for in early summer, and used to populate empty hives. Heather (*Calluna vulgaris*) was widespread in Småland, and its flowering in late summer contributed to the bees' winter stores as well as to the honey harvest. Beekeepers usually killed colonies to be harvested, with sulphur fumes, but in the Baltic island of Öland opposite Småland they took only some of the honey; they estimated how much to leave for winter by hefting the hives, and packed hives with hay or brushwood to insulate the bees against the cold.

Detailed records of beekeeping were made during the 1500s, and Husberg (1985, 1987, 1994) has analysed and interpreted them. King Gustav Vasa (1496-1560) established an effective state bureaucracy operated through bailiffs, and this controlled many aspects of people's lives including beekeeping. The King owned the woods where hives were kept, and half the annual harvest of honey combs had to be delivered to him. In 1555 and 1556 all the King's honey came from Småland: about 5 tonnes delivered to Stockholm Castle in 1555 and nearly 5.5 tonnes in 1556. The King also bought hives from beekeepers for royal apiaries, and for his castles and farms. A peasant farmer might overwinter 3 colonies, get 3 swarms from them next summer, and harvest honey in the autumn by killing 3 of his 6 colonies. His share of the honey might be used for household purposes, or instead of other products for paying taxes, or sold to get extra income. As an example of the records, in spring 1546 one of the King's bailiffs had 223 overwintered colonies in log hives in Småland and Öland. They produced 309 swarms, and in autumn he killed 266 colonies which yielded an average honey harvest of about 3.5 kg per colony.

Husberg (1994) reproduced detailed registers for individual districts in the years 1544 to 1590, of the numbers of colonies that had overwintered, died in winter, and were killed and harvested. In the late 1500s – and especially after 1570 – the climate deteriorated, and there were fewer swarms in summer and greater winter losses of colonies in both hives and natural nests (Figure 26.3b). In several districts 60% of the colonies died during the severe winter of 1561/62. The honey yield per hive, and the total honey production, decreased greatly. The amount of beekeeping also declined because taxes were less regularly paid in honey and, after the Reformation started in 1527, less beeswax was used by the Church.

By the late 1600s bees were also kept in coiled-straw skeps fitted with cross-sticks to support the

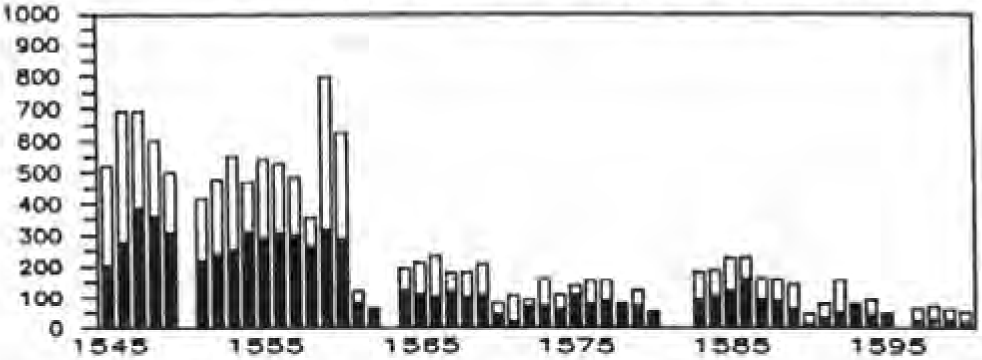


Figure 26.3b Numbers of overwintered colonies and of swarms, in Tuna province, SE Sweden, 1545-1600 (Husberg, 1994). *black* Spring count of overwintered colonies. *white* No. swarms in summer.

combs, and protected from rain by a hackle. There were also some horizontal hives like the Danish *Liggekube*. In 1750 and 1751 an inventory was made of log hives and skeps in every parish throughout Sweden, which Sandklef (1937) published in full. Most beekeepers had between 1 and 3 hives (logs or skeps), but in certain districts in the south – such as Malmö – some had 40 or even more. In the south and west straw skeps were used, in a few areas even into the late 1900s (Berglund, 1960). Elsewhere, in 1750/51 a beekeeper might use only logs, or only skeps, or both. There were no hives north of Stockholm.

Beekeepers had to rely on Danish books until *Nödig Tractat om Bij* by the scientist and engineer Martin Triewald (1728) and *Swenska bi-skiötslen* by N. Koch (1753) were published in Stockholm. Dissertations on bees were written in Latin in 1689 and 1701 (Hebbe, 1939), and Hagström wrote one in Swedish on bee plants in 1768.

Sandklef's 1937 book gave much further information, and there were others by Dahm (1878) and Scharp (1966).

26.33 Norway

There were honey bees in the Oslo region at least by 1200 (Section 9.5), but they may not have been kept in hives until the 1700s.

Much of the following information was published by Torgersen in 1886. Erik Pontoppidan, Bishop of Bergen, reported in 1753 that 'bees are not kept here, since the summers would be far too short', but this was untrue for the extreme south-east. According to Wilse in 1779, bees were kept in the Oslo area from 1740, and one farmer had had 40 hives for some years. A colony had been taken 600 km over the snow to Trondheim and was still alive two years later. The earliest beekeepers were mainly educated people – clergy, government officials and army officers – who in turn encouraged the farmers in their localities to keep bees (Rosenberg, 1988). For instance in 1777 Elaias Fleischer in Denmark wrote:

> I have had correspondence about this matter [beekeeping] with Norway, and know from this that bees are kept and have succeeded in several places. Especially, Lieut.-Col. Heide has done much to expand this activity among farmers and others in the Halden area.

As a result of Heide's activity, Halden (in Østfold, south-east of Oslo) became the greatest centre of expansion. In 1774 Hoff regarded the Idd district, also in Østfold, as much behind some others in beekeeping, but said that it was not unusual to see bees kept round a farmhouse. Skeps seem to have been in fairly wide use. There were later records of beekeeping in more favourable parts of southern Norway, but everywhere the bees were at risk from an extra cold winter or an extra wet summer; both these extremes occurred around 1812, and losses were still not replaced by 1820.

Traditional Norwegian beekeepers had to rely on the Danish books listed in Section 26.31. But in 1809 Selskapet for Norges Vel was established as an organization to promote Norwegian agriculture, and it included beekeeping among its interests. The first beekeeping book was probably *Veiledning i ensiktsmessig biavl* by A.C. Hanson, published in 1844.

26.34 Finland

Almost all of Finland lies north of 60°N, and honey bees did not survive in the wild (Section 9.5). Beekeeping is not known to have existed until the bees were brought by sea from Sweden and Estonia in the 1700s; Huotori (1994) published a detailed account of the introductions. In 1704 Johannes J. Wanaeus presented to the Academy at Turku in south-west Finland a beekeeping dissertation in Latin, *De mellificio*, with chapters on the following: Choosing the apiary site; How to prevent bees absconding; Different opinions on taking the honey; Characteristics of honey bees. Professor Kalm started an apiary at the University of Turku in 1747,

and in 1760 the Bishop of Turku imported a colony in a log hive from Estonia, which died.

In 1800 Suomen Talousseura (Economic Society of Finland) imported 18 colonies which were delivered to prominent farmers, and by 1805 there were about 100 colonies in the country. The first book on bees and beekeeping, published in Swedish, was by Winter (1818); he said that 'the useful bees have not been known or used [by Finnish people] until now, but even the few hives kept in Turku and surroundings have convinced that the climate is no hindrance to the spread of beekeeping'. He had heard of some earlier experiments in Uusimaa on the south coast, and in the Åland islands, but they had not been continued.

The first beekeeping book in Finnish was by Anders Lundgren in 1839 (2nd ed. 1862), and it was also published in Swedish. Traditional beekeeping followed Swedish and German methods, and lasted until after movable-frame hives were introduced in 1867. Rauhala (1953) showed upright and horizontal hives with doors in the side, Polish style, and a tiered box hive. Varís (1993) gave further information.

27

Traditional Hive Beekeeping in Europe III. West of the Forest Zone

From his study on the spread of Roman ideas beyond the Empire, Wheler (1954) concluded that regions through which Roman trade routes passed were in general not greatly influenced by their contacts with Roman culture. Horizontal hives described by Roman authors were not adopted in north-west Europe, although some parts of it were within the Roman Empire. Large logs were not normally available west of the deciduous forest zone, and the most widespread traditional hive was an inverted basket made of woven plant stems (wicker), known as a *skep*; its open mouth was placed on a wooden or stone stand (Figure 27.1a). Coiled-straw skeps gradually replaced those of wicker, and Figure 27.1b shows examples. The following Sections describe first the basic details of skep beekeeping, and then the main traditional types of skep and their use in each country. The skep was not common outside Europe, but in later centuries it became an almost worldwide symbol of industry and thrift as exemplified by bees.

Figure 27.1a Woodcut showing two wicker skeps and a beekeeper wearing a hood with a woven insert, in Sebastian Münster's *Cosmographia* (Bern, Switzerland, 1545).

Figure 27.1b Woodcut showing two tall coiled-straw skeps, from a 1510 edition of the 1495 book by Petrus de Crescentiis (see p. 249). The man is probably about to use his knife to cut out honey combs.

In north-west Europe there was much educated discussion about beekeeping from the 1600s onwards. A number of books on skep beekeeping were printed, almost all of which are listed in one or more of the following bibliographies. In 1881 Auguste de Keller, Director of the First International Museum of Apiculture in Milan, compiled a *Bibliographie universelle d'apiculture* with over 5000 entries, covering all languages and countries. Droege (1962/68) listed publications in German, and Casteljau (1983) books published in French. IBRA (1979) produced an annotated bibliography of books published in Britain and Ireland. The last two indicated libraries holding each book.

27.1 Basic details of skep beekeeping

27.11 Swarm beekeeping

In open land in the cool temperate zone, the main honey flows tended to occur in mid to late summer, after flowering in deciduous forests (Chapter 26) had finished. A type of traditional beekeeping was developed that made use of these later flows, which lasted into August and September where heather grew. It was often called swarm beekeeping (e.g. Armbruster, 1928; Berner, 1954) because it depended on the production and hiving of swarms in early summer, which stored additional honey from the late flows. Constant attention was needed during the swarming season, and the work was best done by a beekeeper who made this his main occupation. Beekeepers used upright skeps or other hives open at the bottom, and they encouraged colonies to swarm by making the hives small so that the bees became crowded in late spring. The skep size recommended in twelve English beekeeping books between 1593 and 1851 ranged from 9 to 36 litres, often around 20 litres – smaller than most log hives, and much smaller than a modern hive (40-80 litres or much more). Skep beekeepers eagerly watched for swarms, and since Ancient times it was believed that a flying swarm could be induced to settle by 'tanging' – striking two metal objects together to make a loud noise, as in Figures 33.4a and 33.4c.* Some methods for 'taking' a clustered swarm are shown in Figures 27.1c and 37.2c, and the captured swarm was put into an empty hive. It developed and stored honey, and might swarm again. In many regions including north Germany, tall narrow skeps were favoured for swarm beekeeping, because the small diameter made them more satisfactory than wide skeps for newly hived swarms, and combs built in them were more securely attached to the skep (Jung-Hoffmann, 1990).

A swarm beekeeper finished the summer with several times as many hives of bees as in the spring. But he wintered only sufficient 'stock hives' (with their honey) for use in spring, allowing for the death of some colonies during winter – 50-80% in some areas (Armbruster, 1928).

Swarm beekeeping was done in most of north-west Europe, and as far south as the Pyrenees and Alpes-Maritimes in France. In some wooded areas hives were upright logs instead of skeps. In more remote areas swarm beekeeping continued with little change until the 1900s. In England Richard Smith's book (1839) still strongly recommended it, and also – with some modifications – Pettigrew's (1870), which advocated much larger skeps, 12 inches high and 16, 18 or 20 inches across (40 to 50 litres). He learned how to handle the larger colonies, and got higher honey yields.

*Bees have no obvious hearing organ, but see Section 52.52.

Figure 27.1c Some methods of taking a swarm, according to where it had settled (E. Alphandéry, 1911). *above* An accessible branch where a swarm had settled was shaken to dislodge the bees so that they dropped into a skep held below. A low branch was cut on each side of a swarm clustered on it, and the swarm carried on the branch to the new hive. *below* A swarm on a vertical surface was brushed into a container held close below. A skep might be fixed above an inaccessible branch, and the bees driven up into it by vigorous smoking.

27.12 Harvesting honey, including driving bees

With horizontal hives in the south of Europe, beekeepers could harvest some honey combs from one end of each hive and leave the rest for food during the relatively short winter. In the north where the winters were longer, colonies needed more food; swarm beekeepers left all the honey in hives to be overwintered, and harvested all of it from the other

hives at the end of summer, after killing the bees. It was widely recommended, for instance by Butler (1609) in England, that beekeepers should winter medium-weight colonies, and kill the heaviest (yielding most honey) and the lightest (which would starve in the winter).

The bees were killed by the following methods.

- Sulphur fumes, for instance by standing the skep over a pit containing burning sulphur, or candles or paper darts impregnated with it; in 1953 I found darts being used in Farndale in the north of England.
- Smoke from the giant puffball (*Langermannia gigantea*), which produces hydrogen cyanide when burned (Section 34.4).
- Drowning, which was done for instance in parts of the Caucasus region, Austria and the Pyrenees, and around Bucharest. The skep was placed at the bottom of a sack, and the closed sack immersed in water which might be hot. In England, Lawson (1618) recommended drowning, but Butler (1609) disliked it because it 'hurteth the Honie, and doth the Hive no good', and in Saxony Eldingen (1578) did not do it. There was a belief that bears also drowned bees in skeps to get at their honey (Figure 5.2a).

Another method, which did not involve killing the bees, could be used where there were sufficient late honey flows. Around midsummer, all the bees were 'driven' out of an upturned hive into an empty one (Figure 27.1d), before taking all the honey. The earliest reference to driving in England is probably that in Thomas Tusser's beekeeping instructions in verse, printed in 1557. The 1580 edition says 'At Midsummer drive them, And save them alive'. Butler (1609) gave more detailed instructions. Early in the morning at or near midsummer, fix the skep to be driven in an inverted position, quickly cover it with an empty skep, the two skeps being mouth to mouth, and seal the join between them by wrapping a cloth round it. Clap (drum) rhythmically with the hands on the sides of the full hive, pausing every now and then, and the bees will walk up into the empty hive. When most have done so, set the upper skep – now containing bees – on the stand the lower skep had occupied, so that any bees flying out will return there. Driving does not easily dislodge bees covering brood, and various strategies were devised for persuading bees on brood to leave it. The intention was that the driven bees should have time to build combs in the new hive, rear brood and store honey before the winter. But bees driven into a hive without any

Figure 27.1d Driving bees from one coiled-straw skep into another, England, early 1900s (photo: A. Watkins, Hereford City Library no. 2613).

combs often did not prosper, and Butler quoted the proverb: 'All covet, all lose.'

Alternatively, the driven bees were added to another of the beekeeper's colonies to strengthen it, or sold for a similar purpose. (To prevent fighting, bees to be united were sprinkled with sugar syrup, preferably strongly scented, for instance with mint.) During the 1900s, surplus bees after the heather flow in the Lüneburg area in Germany were sold for the production of bee venom (Section 51.4).

The practice of killing colonies at the end of summer and taking all their honey was reintroduced during the 1900s by beekeepers using package bees, notably in North America (Section 44.32).

27.13 Alternative practices to swarm beekeeping

One practice was to cut and harvest a few outer combs after smoking the bees off them, as was done earlier from nests in trees, and then from trunk hives (Section 26.11). In Germany this operation was called *zeideln* (to cut), whether the bees were in tended nests, trunk hives or skeps. In England Remnant (1637) recommended a beekeeper to cut off the lower part of two or three middle combs in a skep that was full of honey in the summer, 'so that they [the bees] will worke anew, and breed'. A variant of this practice was adopted with wide low skeps such as the *Alemanischer Rumpf* in Germany (Section 27.21).

Beekeeping with straw skeps was improved in several ways from the late Middle Ages onwards, and by the early 1800s there was a growing opposition to routine killing of bees (Chapters 38 and 40).

27.14 Wicker and straw skeps

Skeps were less heavy than log hives, and usually smaller. They were made of either woven wicker or coiled straw, i.e. lipwork (Figures 27.1a, 27.1d). Baskets were made by both techniques in Antiquity, and skeps of either type could have been used much earlier than dates indicated below. Well made straw hives lasted longer, and were more satisfactory for transport, partly because the weatherproof coating of clay and cow dung necessary on wicker skeps easily broke off.

The distribution and use of skeps has been extensively discussed, especially by German authors, notably Armbruster (e.g. 1926, 1928) and Jung-Hoffmann (1990) from studies of surviving hives and of past records, and also by Schier (1939, 1972). Brinkmann (1938) collected linguistic evidence, as did Legros in Belgium (1969) who did not agree with all of Brinkmann's statements.

The woven wicker skep (*Rutenstülper*, inverted wicker vessel) was used earlier and over a wider area than the straw skep, including some places within the forest area. The earliest known remains are dated to between AD 1 and 200 (Figure 27.1e); they were dug up in the Feddersen Wierde, a peat bog near Wilhelmshaven on the North Sea coast of Lower Saxony (Ruttner, 1977; Segschneider, 1978). Wicker skeps were illustrated in a number of mediaeval illuminated manuscripts; see for instance Figure 27.5a. The skep was originally woven on a whorl of thin branches (still attached to a length of a main branch) of a fir or spruce tree. The branches constituted the main stakes or, alternatively, these might be created by splitting most of the length of the main branch. The stakes were bent down during weaving, and subsidiary stakes were inserted between the main ones as the diameter of the weaving increased. The protruding 'crownpiece' at the top was left to serve as a handle. Skeps in Figure 27.1a were made in this way, and Armbruster (1926) described one from Serbia. Later, the stakes were sometimes separate, and a crownpiece was added.

Figure 27.1e Upper part of a woven wicker skep with a crown piece, Lower Saxony, AD 1-200 (photo: W. Haarnagel).

Coiled-work skeps could be made only where suitable reeds or grasses grew, or a fairly long-stemmed cereal was cultivated. Figure 27.1f shows some of the tools used, and how the work was started. The thickness of the coil of straw was kept constant by enclosing it in a girth, and feeding in more straw as necessary. Coils were bound together with a long stem, for instance of bramble, split into three or four strands with a wooden cleaver, and holes for inserting the binding cane were made with a bone or metal awl. Smit (1967) and Brekelmans (1979) described Dutch skep making, and Alston (1987) described English methods.

Several long thin sticks were often fixed across the interior of a skep before it was used, to anchor the combs that would be built in it and prevent their breakage.

Whereas the shape of a wicker skep could be varied only by adjusting the length, spread and curvature of its stakes, many different shapes could be made with coiled straw. The top could be domed or flat, and completely closed or provided with a central hole, and later a stack of open-ended shallow cylinders was used as a hive.

27.2 Traditional beekeeping in Central Europe

27.21 Germany west of the Elbe

Wicker skeps

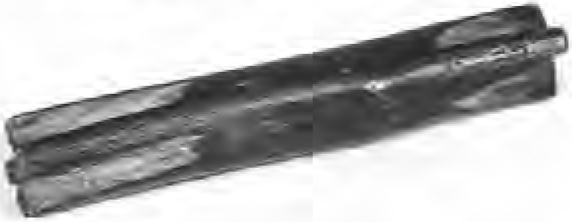
The earliest known skep, remains of which were found in north Germany, is described above (Figure 27.1e). Armbruster (1931b, 1939a) collected mediaeval and later references to wicker skeps; an 1162 manuscript from Kloster Zwiefalten near Ulm shows a man holding what might be one by its crownpiece (Armbruster, 1938a). But these skeps seem to occur less commonly in German than in English mediaeval illustrations.

Figure 27.1f Tools for making coiled-straw skeps (IBRA Collection). A, B and C are English; D is Dutch.

A Girth made from a cow's horn (B53/38a).

B Leather girth in position, at the start of a skep (B53/38b).

C Awl made from a chicken bone, for piercing the straw to insert the binding material (B53/38c).



D Cleaver for splitting cane or brier, to use as binding material (B68/68).

Coiled-straw skeps and their variants

The coiled-straw skep (German *Strohkorb* or *Stülper*, i.e. inverted straw basket) is generally considered to have originated among Germanic people west of the Elbe (Armbruster, 1926; also Schier, 1939). Pictures of skeps are known from the late 1400s; Figure 27.2a shows two on a wooden stand in 1475, and Figure 27.1b somewhat taller ones in 1510. The following brief summary of recognizable variants is based on descriptions, illustrations and distribution maps of material in the Armbruster Collection in Berlin (Jung-Hoffmann, 1990).

The Alemanni were a people in Alsace and what is now south-west Germany, and the *Alemannischer Rumpf* was used there and in the Bavarian-Austrian area. It was a wide, flat-topped skep as in Figure 27.2b, said to have originated in the Black Forest across the Rhine from Alsace. The flight entrance was sometimes formed as a channel in the wooden base. Honey combs were cut out at the back of the skep, and the skep then turned through 180° so that the resulting empty space was near the flight entrance, where the bees would most readily build new combs. This operation ensured a regular renewal of combs in which honey was stored. In Hessen to the north there were barrel-shaped or near-spherical skeps with the flight entrance cut in a wooden rim to which the bottom coil of straw was fastened. By the 1800s a small removable cap was often added for honey storage. Straw skeps used in Franconia, a mediaeval duchy in south and west Germany (Armbruster, 1926, 1928) were very similar to those in England, and were protected by hackles.

The skep in the Lüneburg area (below) also spread

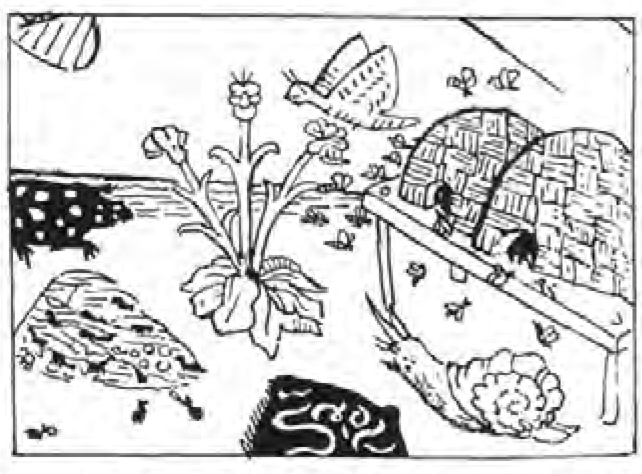


Figure 27.2a Part of a woodcut showing two skeps, from *Buch der Natur* (K. von Megenberg, Augsburg, 1475). This is the earliest known illustration of hives in a printed book. From their shape, they were made from coiled straw, not wicker.

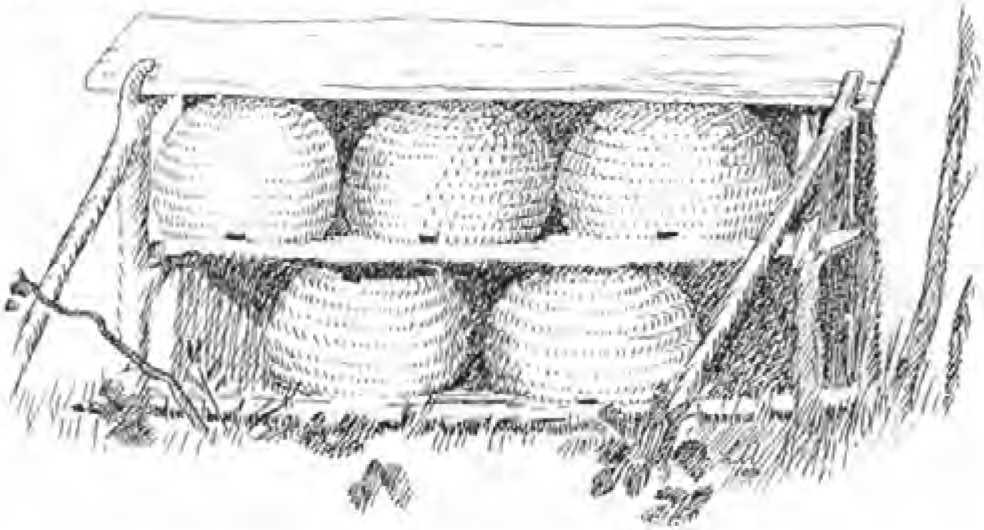


Figure 27.2b Straw skeps in a small shelter, 1519, drawn from Grünewald's Stuppach Madonna (Armbruster, 1926). Stuppach is east of Heidelberg.

through Lower Saxony. It was relatively tall, with a flattish top and a high flight entrance (Figure 27.2c), and its tight construction gave it great strength and durability: there are many records of skeps in use for a hundred years or more. During the 1100s, the Bishop of Hamburg received a tenth of the honey – as of other produce – obtained by Hollanders who had been brought to drain and cultivate the marshy wasteland on his estates (Duby, 1962), and skeps in the Lüneburg/Hamburg region were notably similar to those in the Netherlands; see Section 27.4.

To the west of Lüneburg the skep was narrower, and in some areas had several flight entrances and a small central hole at the top. Towards Schleswig-Holstein, the upper surface of the skep was more rounded, but in Mecklenburg and Pomerania the top was flatter. Very large skeps with a pointed top were widespread in East Prussia. Armbruster (1939c) published many German and Dutch drawings made between 1581 and 1725, in which straw skeps – almost all tall, and some with high entrances – were used as emblems. A type of ornamented hive (*Bannkorb*) was developed from the Lüneburg skep, equivalent to the *Figurenstock* made from an upright log (Figure 26.2f, in Poland). It incorporated a wooden panel carved to represent a human face, or a complete person as in Figure 27.2d. Jung-Hoffmann (1993) published many examples, and a map showing the area they came from in Lower Saxony.

Figure 27.2c Lüneburg skeps made about 1800, still in use in 1952, with Dr Erich Wohlgemuth (photo: E. Crane).

For many centuries the Lüneburger Heide south of Hamburg, with much heather (*Calluna vulgaris*), was a centre of swarm beekeeping. This was described in a book by Eldingen (1578), whose knowledge and practices included the following.

- He transferred bees into an empty skep by driving them, before harvesting their honey.
- He used a cloth to close the mouth of a skep of bees when transporting it, and also to prevent bees escaping when driving them.
- He knew that enough honey must be left in hives for winter to last the bees until apple blossom in the spring.
- If some hives had insufficient honey for winter, he gave them honey combs taken from other hives after killing the bees in them with smoke.
- He knew that a 'ruler' or 'instructor' (*Weisel*) piped during the swarming season; he said that if a young ruler sang brightly (or dully) an afterswarm would issue soon (or later); in England the sound was likened to that of a 'bugle horn'.
- He knew that spy [scout] bees 'guided' a swarm to a nest site.

Figure 27.2d *Bannkorb* with a carved figure of the Virgin Mary, from Röddensen bei Lehrte, Lower Saxony, Germany (photo: Bildverlag Freiburg im Breisgau no. 1851).

Eldingen took bees to the buckwheat and heather, both late honey flows, and he believed that late swarms were valuable. If cold weather was expected he placed the skeps on straw, and pushed this up gently as far as the combs; the straw had to be removed when frosts had finished, or the skeps would become mouldy.

Eldingen knew that the swarm bees ate honey before leaving the hive, and (unlike Jacob, 1568) that the ruler heading the colony flew with the prime swarm – but he did not know that this bee was female, or appreciate her biological function. He said that the swarm bees in the air could smell their ruler, who was sometimes unable to fly and fell to the ground. Bees in a colony without a ruler collected no pollen and did little work. If this situation continued for a long time, many drones appeared. To give the colony a new ruler, Eldingen united with it a small afterswarm (which would contain a virgin queen), or put in it a cell containing a young ruler, cut out from a hive whose bees had just swarmed. He stored rulers in individual cages fixed on to combs in a colony where young bees would feed them, and used a cage to introduce a ruler to a colony. He treated wax moth infestation – and also 'foul brood' – with smoke.

Armbruster (1939b) reprinted Eldingen's book, with editorial notes, and compared it with Jacob's book published ten years earlier. Fraser (1942), who compared it with six English books that appeared between 1523 and 1641 (Section 27.51), judged Eldingen to be a better beekeeper than the English, and to have a greater knowledge of the behaviour of bees.

Records in more recent times show that hives were constantly watched during the swarming season in early summer, and as each prime swarm left the hive it might be confined in a swarm-catcher (Figure 27.2e) consisting of a long tube of netting kept in shape by three hoops. Immediately the bees in a skep showed by their restlessness that the swarm would very soon issue, the open end of the net was placed over the flight entrance, so that the swarm bees moved into the net and to the upper (closed) end. After 6-10 minutes the hive end could also be closed, and the net hung up in the shade until evening. This traditional beekeeping still continues on Lüneburger Heide, and complete details of the activities through the year were recorded in a film with a commentary in both German and English (Kleindienst-Andrée *et al.*, 1987).

The *Thuringer Walze* was a horizontal hive of coiled straw, used south-west of Berlin.

Early books and laws

Several Latin manuscripts from the 1200s and later, which treated bees on the lines used by classical writers, were printed from the late 1400s. They included *Bonum universale de apibus* by Thomas de Cantimpré (1472, in Cologne) discussed by Armbruster (1942). *Pantoplion* by Georgius Pictorius who lived in Baden was printed in Basle, Switzerland, in

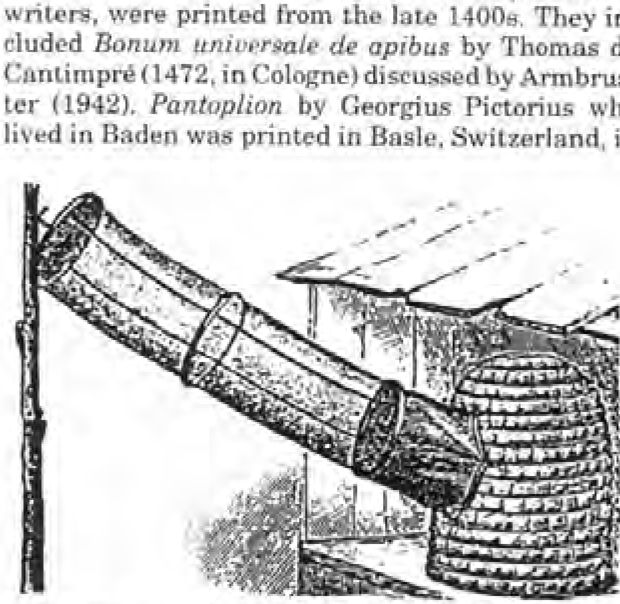


Figure 27.2e Swarm catcher fitted to a skep such as those in Figure 27.2c (Gravenhorst, 1873).

1563; it included a section *De apibus, cera, melle* which was discussed by Armbruster (1943). In the beekeeping section of *Rei rusticae* (Cologne, 1570), Conrad Heresbach aimed to adapt Roman writings to the needs of northern Europe.

According to a 1553 Bavarian law, the owner of land where someone else put livestock (sheep or bees) was entitled to the *increase* (lambs or swarms) as recompense, and the livestock had to be left there for three years (Armbruster, 1961b).

27.22 Austria

Many historical records testify to the production and use of large quantities of honey, mead and wax, but it is often not clear whether these were products of hive beekeeping or tree beekeeping, or perhaps more probably from both. By the 700s Christian churches, abbeys and convents needed much wax for candles, and Scharl (1958) cited several examples. Two *Zeidler* were assigned to the monastery at Kremsmünster in Upper Austria when it was founded in 777, and Otto II (*r.* 973-983) granted it several apiaries, with five beekeepers, in Eberstallzell. In the 1000s beekeeping flourished in Styria, and there was jurisdiction to regulate the taking of swarms by families of *Zeidler* in Holleuburg.

In 1592 Colerus reported that when he travelled through Lower Austria north of the Alps he saw hives of wooden boards, and these were probably horizontal. Some Austrian beekeepers believed that bees in one horizontal hive gave more honey than those in three upright ones, and that they did not swarm as much (Newald, 1953). According to Hirsch in 1773, beekeepers in Lower Austria used log hives, board hives, and skeps of reeds or straw. In some parts a *Rauchfangstock* (chimney hive) was made of tall narrow boards, wider at the bottom than at the top. These hives usually stood on a shelf against a house wall and might be placed upright or in a sloping position (Armbruster, 1928). Hives in the Tyrol were low flat-topped skeps, rather similar to those in Figure 27.2b. In some remote valleys both upright and horizontal hives were used up to the early 1900s.

Beekeeping had more or less collapsed during the Thirty Years' War (1618-1648), and many colonies died. A resurgence under Ferdinand III continued after his death in 1657, and the first beekeeping ordinance in Lower Austria was enacted in 1679. According to Scharl (1958) these measures did not check the decline in beekeeping, and the revival came only during the reign of Empress Maria Theresa who ruled over Austria, Hungary and Bohemia from 1740 to 1780. She removed all tithes from beekeeping, and the restrictions on the number of hives a beekeeper could have. She promoted beekeeping in other ways: 'Beekeeping is an important part of the agricultural economy, and so long as foreign beeswax and honey are imported, no one can doubt the value of these products.' In 1769 she set up a beekeeping school in Vienna, and Anton Janscha who was appointed to teach beekeeping introduced improved colony management using wooden boxes (Sections 25.6 and 40.5).

In 1781 the Holy Roman Emperor Josef II ordered payment of a premium to the beekeepers in each district of his provinces who kept the most colonies. Near Vienna in 1850 Baron von Ehrenfels had a thousand colonies in skeps, to which he added a separate honey chamber at the top; he also migrated his hives. He was Austria's greatest 'bee master' (Scharl, 1964), and his 1829 book was republished until 1922.

27.23 Switzerland

The earliest reference found to hive beekeeping in Switzerland was in 834, when the Benedictine Abbey at St Gallen (south of Lake Constance) received among other livestock *vii examina apium* (7 swarms – or colonies? – of bees). In 614, when St Gall had founded the Abbey, hive beekeeping already existed in his native Ireland (Section 27.52), so it seems possible that he introduced it at the Abbey. In the Thur valley west of St Gallen, where the Abbey purchased land from the Count of Toggenburg in 1469, wicker skeps survived into the 1900s. Münster's *Cosmographia*, published in 1545 in Bern, showed wicker skeps (Figure 27.1a).

Between 1578 and 1586 Canon Adrian II kept records of his upright log hives in the Rhone valley just above Sion. In different years, between 44 and 72 of them were occupied by bees, which produced between 6 and 27 swarms (Volken, 1966). His total annual honey harvest varied from 19 to 149 kg, and the average yield per hive can be calculated for three years as 1.7, 2.0 and 2.5 kg. Sooder's 1952 book gave a valuable account of Swiss beekeeping history, with many records from the 1400s and later.

In Canton Grisons, detailed plans were made of properties in Monticello in 1793, and six showed an apiary: with 6, 8, 10, 14, 20 and 26 hives (Santi, 1983, 1993). Figure 27.2f shows part of one of the plans.

Hives in different areas were probably derived from those used by peoples in adjacent countries, including the Alemanni in present south-west Germany and Alsace (Section 27.21) who conquered the Swiss in the 400s and 500s after the Romans had left.

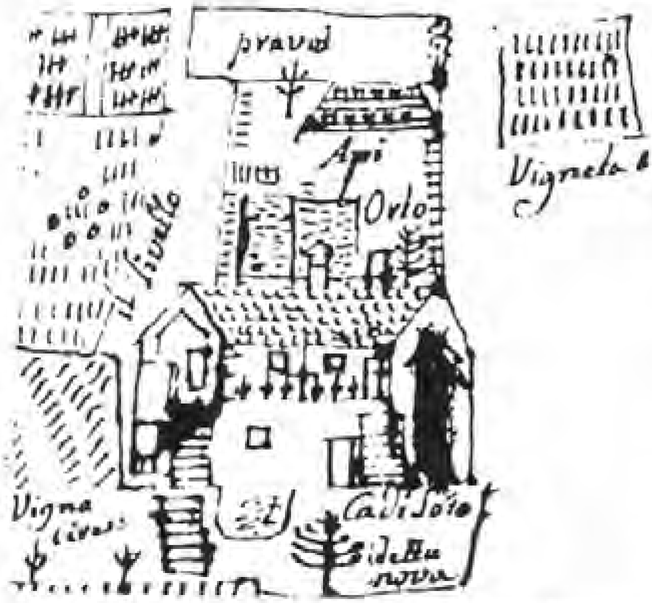


Figure 27.2f Part of the plan of property of the heirs of Domenica Tella, Grisons, Switzerland, 1793 (Santi, 1983). *api* = apiary; *vigneta* = vineyard; *vigna ciraso* = cherry orchard; *orto* = vegetable garden.

Figure 27.2g shows where the various hives were used, and types that were most widespread have already been discussed and illustrated:

1. coiled-straw skep: W Germany (Figure 27.2b); France (Figure 27.3c)
2. woven wicker skep: W Germany (Figure 27.1c)
4. horizontal board hive with entrance at end: Italy (Figure 25.2a)
5. upright hollow log: Germany (Figure 26.2a)

Armbruster travelled extensively in the Alps in the mid-1920s, and in 1928 he described in detail the traditional beekeeping still existing in remote areas.

Most skeps were kept under cover, typically on a shelf against a house wall with some form of protection overhead. Or a free-standing shelter was built, consisting of a roof, back and usually sides, with a narrow passage for the beekeeper behind the shelf on which the hives stood. In more recent times a rather elaborate bee house became a feature of the Swiss landscape; this had four walls, window, door and ridged roof, and often many internal fitments (Section 32.32).

The richness and variety of beekeeping terms in Swiss languages indicate a long relationship between beekeepers and their bees, in many parts of the country. Sooder (1952) and Wissler (1953) discussed terms in French, German and Italian, and in Rhaetoroman – an Ancient language based on Latin used in Canton Grisons in south-east Switzerland, which had been conquered by the Romans.

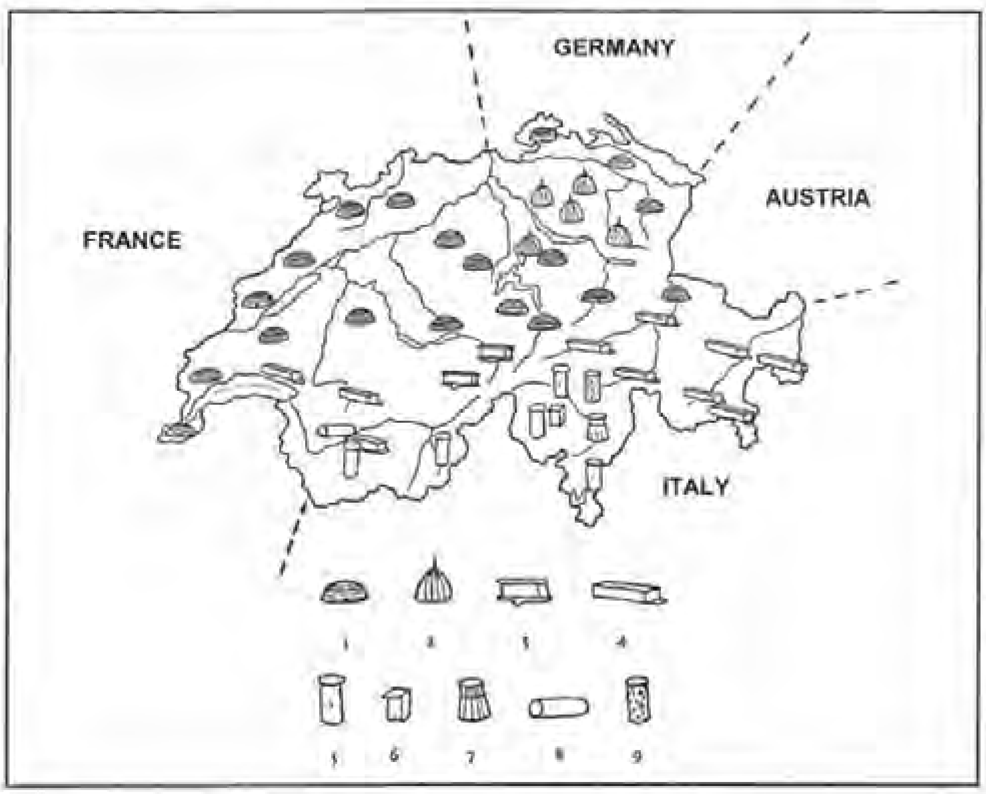


Figure 27.2g Map showing regions of Switzerland where different types of hive were used (Sooder, 1952).

1. coiled-straw skep
2. woven wicker skep
3. horizontal board hive (entrance in centre)
4. horizontal board hive (entrance at end)
5. upright hollowed log
6. upright board hive
7. upright barrel hive
8. horizontal hollowed log
9. upright bark hive

Morgenthaler (1938) wrote about Rhaetoroman beekeeping.

27.3 Traditional beekeeping in France

The *Capitularies* of Charlemagne from 799 and later mentioned 'hommes employés aux abeilles'; they might have looked after hives, or collected honey combs from nests in trees, or both; some dues had to be paid in honey, beeswax and mead (Guérard, 1853). The *Leges Barbarorum*, laws of nations conquered by Charlemagne which included most of France and Germany, laid down severe penalties for the theft of hives or honey (Guérard, 1836/44). They also mentioned *apum vasculum*, which Fraser (1958) equated with a skep of wicker, not straw.

Duby (1962) published a number of early mediaeval inventories, and some French ones mention hives. Around 800, a royal estate at Annapes on the border of Flanders and Artois had three muids (c. 750 litres) of honey among its stock from four gardens, and also 'a little courtyard surrounded by a hedge, well ordered and planted with trees of different kinds', so the honey probably came from hives. In the 800s a lord's farm at Longeville near Rheims had 21 hives as well as 87 geese, 44 ganders, 157 hens and 102 chicks. Two passages from the 1100s probably refer to individuals who took harvests from nests of bees in trees and also had bees in hives, and therefore wanted swarms. Rights over the land of Bois-Ruffin, granted to Geoffrey d'Arron by the Abbot of St Pere at Chartres, included ownership of a 'hive of bees he might take in the trees'. But if one of the settlers on the land took the 'hive', he was to have half. After the Abbey of Ferté-sur-Grosne was given land by Hugues de Chilley and his brother and four sons, any bees found on it by the Hugues family belonged to them, but if someone else found bees, the honey, wax and half the bees went to the forester (Hugues's son) and the monks. The finder presumably kept half the bees; such a division was widely referred to in Europe, but there is no explanation of how it was done, and Armbruster (1961b) concluded that half their value would be handed over.

Most early representations of hives in France are from the north and show wicker skeps. There are sculptures from about 1120 in Cluny Abbey and the Madeleine Chapel at Vézelay (Crane, 1983a, Figs 244, 245), and Figure 27.3a shows two in 1551. But coiled-straw skeps were also used.

In the south, most traditional hives were upright, made of wood or cork. The map in Figure 27.3b shows hive types in the different regions except the extreme north. Legros (1969) published more detailed maps of hives, and Chaise (1989) described those in the central region of Creuse. In Figure 27.3c all hives shown except two are fairly similar to those in Germany. The cork hive from Var was common in Spain and Portugal and was also used in south-east France including the eastern Pyrenees; wherever the cork oak grew, beekeepers valued the bark for hives because of its good thermal insulation. Secondly, in certain heather areas in the south-west, including the Landes, a skep woven from chestnut slats had a small bulbous part at the top; a late swarm obtained in these areas was found to winter better in it than in the wide top of the usual skep.

Figure 27.3a Wicker skeps on a wooden stand, from *Ari Apollonis Niliaci*, a book of emblems by Jacob Kerver, Paris, 1551. A swarm, led by its queen, is shown leaving one hive.

Vestiges of Celtic beekeeping survive in Brittany (Pichon, e.g. 1987); there was a great dependence on swarms, and Breton terms show similarities with those in Celtic Wales (Section 27.52). In 1906 Henri published a beekeeping book in Breton.

Armbruster (1928) and Fraser (1951c) gave further details of early French hives and beekeeping, and books by Alphandéry (1911), Marchenay (1979) and Adam (1985) included many illustrations; see also note on p. 257. Gilliéron (1918) and Legros (1969) made detailed studies of early French beekeeping terms, especially for bee and hive.

Roman writings formed the basis of the early books mentioned below, although there seems to be no evidence in France of horizontal hives such as

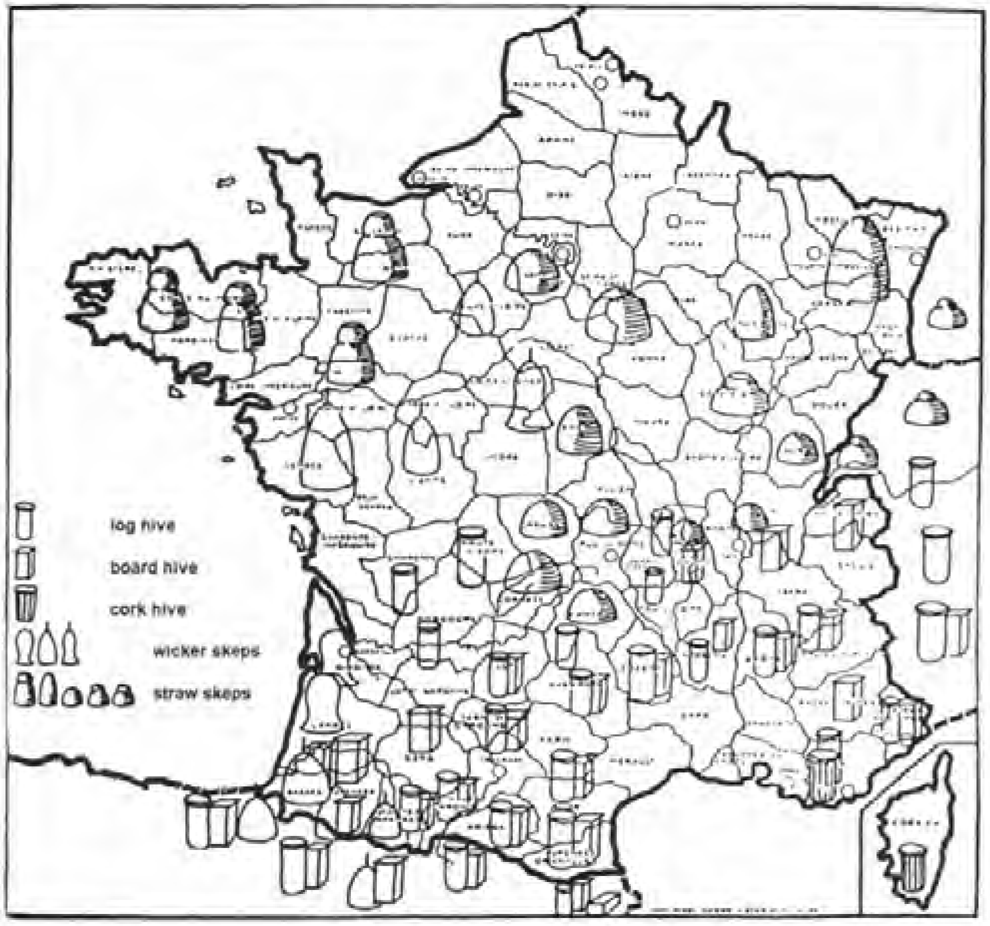


Figure 27.3b Distribution of types of traditional hives in France (Brinckmann, 1938; see Legros, 1969).

Figure 27.3c Models of traditional French hives (photographer unknown). *above* Wicker skep, Gâtinais; two wide low coiled-straw skeps, Creuse and (with cap) Vosges; upright cork hive, Var. *below* Upright board hive, Vaucluse; woven wicker skep, Cher; skep with bulbous top (see text) woven from slats of chestnut (*Castanea*) wood; upright log hive, probably chestnut, used in SE France.

those used in Roman times in Italy and Spain. Various Latin texts with comments on bees written between 300 and 1300 (Table 52.1A) were known in France (Fraser, 1951c); their authors included Ambrose, Isidore, Avicenna and Averroës (translations from Arabic), Thomas de Cantimpré and Bartholemaeus Anglicus. *Opus ruralium commodorum* by Petrus de Crescentiis was translated into French in 1373 by order of King Charles V, and printed in Venice in 1495 and in Strasbourg in 1510; see Figure 27.1b. *Pharmetra doctorum philosophorum* by J. Mantelin of Strasbourg (1472) dealt with bees. Charles Estienne's *Praedium rusticum*, published in Latin in Paris in 1554, had a section on beekeeping. After Estienne's death, J. Liébault revised the book and translated it into French as *L'agriculture et maison rustique* (1570); it was still based on Roman writings. Board hives were regarded as the best, then those of cork; woven and earthenware hives were less good, and those of straw or brick were not approved. But some information was post-Roman: honey could be harvested by driving the bees into an empty skep, using smoke or selected herbs; the beekeeper was recommended to protect himself with a mask and gloves. Pierre Constant's book *Les abeilles et leur état royal* was published in Paris in 1582, and *Théatre d'agriculture* by Olivier de Serres (1600) had a chapter on beekeeping. *Le nouveau théatre d'agriculture* by Le Sieur Liger followed in 1723, and many later editions kept the beekeeping part up to date.

Fraser (1951c) and Casteljau (1983) mentioned other books published in the 1600s and 1700s.

27.4 Traditional beekeeping in the Low Countries

Beekeeping practices were transmitted during the Anglo-Saxon period (500s-700s) by the westward movements of peoples, and transmission may have also occurred later, perhaps by the 'Hollanders' who worked in Lower Saxony in the 1100s (Section 27.21). Skeps used in the Lüneburg area were similar to those in the Low Countries, where the traditional beekeeping is shown in engravings and paintings from the 1500s onwards.

27.41 The Netherlands

The most common hive was a coiled-straw skep, mainly similar to the type used in Lüneburg; it was migrated to the heather, especially in the Veluwe, and its use continued longer than in most countries. Tall woven skeps, also used, were developed into an art form by the addition of an ornamented protective outer layer, as for example in Figure 27.4a. Jacobs and Plettenburg (1978) described some of the skeps, and many examples are displayed with other traditional equipment in beekeeping museums (Appendix 2). Skep making is kept alive by a popular interest in the coiled-straw technique; Smit (1967) published illustrated instructions and Brekelmans (1979) a practical handbook.

Figure 27.4a Woven skep (swan's neck decoration), Netherlands (photo: J. Mommers). See text.

Dutch beekeepers developed two activities that hardly existed elsewhere: beekeepers' guilds from the 1400s (Section 42.22) and 'bee markets' from the 1850s. The markets were held in different towns to enable beekeepers to sell swarms in skeps (Figure 27.4b), often after the buckwheat flowering when many newly hived swarms were available. Beekeepers living near a heather district came to buy them to take to the heather for an additional honey harvest. The largest and most famous bee market was at Veenendal; 2070 skeps of bees were taken there in 1850 (the first year), 1362 in 1867, and 4555 in 1872. The average selling price was three Dutch florins.

Figure 27.4b Dutch beekeepers at a bee market waiting to sell their skeps of bees, 1976 (photo: Het Vrije Volk, Rotterdam). Skeps are closed at the bottom with sacking.

Beetsma (1977b) gave details of some other markets. Many died out as modern beekeeping replaced the use of skeps, but in 1990 the journal *Bijenteelt* listed 27 in various towns between mid-June and October. In May 1990 I saw only one skep of bees on sale at the market in Baarlo.

The first book on bees printed in Dutch, in Zwolle in 1488, was *Dit is der bien boeck*, translated from Thomas de Cantimpré's book in Latin (see below). Skeps illustrated in the 1488 book and in its 1515 Leyden edition are similar in shape to some in Flemish engravings made in the 1580s (e.g. Figure 27.4c), but appear to be woven. In 1569 came *De bijen-korf der H. Roomsche Kerke* by Filip Marnix van St Aldegond, a satire on the Roman church which was also published in English in Amsterdam in 1579; see Crane (1980a). The first book on beekeeping by a Dutch author – T. Clutius (Dirk Cluyt) – was *Van de byen* ... published in Leyden, 1597, and there were many later editions (Armbruster, 1940a). The use of skeps continued into the 1900s, and Veluwe (1982) described methods in different parts of the Netherlands.

27.42 Belgium and Luxembourg

Brussels flourished as a commercial centre from the 900s, and about 1260 Thomas, Canon of Cantimpré nearby, wrote *Bonum universale de apibus*. On the left of each page were statements about bees and, on the right, suggestions of moral lessons to be drawn from them.

The land which is now Belgium belonged at various times to Burgundy, Spain, Austria, France and the Netherlands, and it became independent only in 1830. It incorporated part of Flanders, and pictures by three Flemish artists in the 1500s showed details of traditional beekeeping. All the hives were tall straw skeps with a flight entrance well above the base, housed in a thatched shelter near farm buildings. Figure 27.4c shows the scene by Pieter Breughel. In one by Jan van de Straat of Bruges (Figure 53.3a), pigs and poultry were kept near the hives. There, and in the rather similar one by Hans Bol of Antwerp (Figure 33.4c), women and children as well as men were involved in beekeeping activities, and all wore protective clothing that looks effective. Similar hives were used up to the 1900s, and in 1953 I found an apiary containing both wicker and straw skeps behind a petrol station on the Brussels-Antwerp autoroute. A night scene by Jan van der Straat is shown in Figure 52.7b, and the transport of hives in Figure 35.2b.

Alexandre de Montfort published books about bees in 1646 and 1649, in Liège and Antwerp.

Luxembourg was a duchy after 1354, and in the late Middle Ages the Duke of Luxembourg had hives in numerous apiaries on his estates. His beekeeper used a cart to visit them and to carry the harvest of honey combs to the Duke (Armbruster, 1956a). Records of legal proceedings between 1459 and 1738 show that a high value was placed on natural nests of bees. Poos (1978) deduced from this that the bees

Figure 27.4c Flemish beekeeping scene, by Pieter Breughel the Elder, 1565. It has been suggested, e.g. by Grimm (1993), that the men might be stealing the hives.

were wanted to populate hives, and that beekeeping had superseded honey hunting in Luxembourg by the mid-1400s or earlier. Conical woven wicker skeps were used into the 1900s (Crane, 1983a).

27.5 Traditional beekeeping in Britain and Ireland

27.51 England and Scotland

Hive beekeeping was almost certainly introduced in the east of England from continental Europe and transmitted through Britain from east to west. We do not know when the introduction occurred, but I think that it was well before Roman times (Section 27.53). There is no evidence of Roman influence on beekeeping, and certain pottery vessels found in Wiltshire and Surrey which had been regarded as Romano-British hives cannot be accepted as such (Crane & Graham, 1985). The only reference known to beekeeping or honey from Roman Britain is an entry *lini mellari* (which could refer to beekeeping linen or cloth, or something similar) in an uncompleted list of items supplied to the Roman garrison at Vindolanda near Hadrian's Wall in the north of England; it was found in 1993 and dated to *c.* AD 100 (Vindolanda Tablet Inventory no. 93/1350, unpublished*). A coarse linen cloth could have been fastened over the mouth of a skep to confine the bees in it, or used to strain honey harvested from hives or natural nests.

Wicker skeps were mentioned about 705 by Aldhelm, Abbot of Malmesbury and later Bishop of Sherborne in the south of England. His passage about bees can be translated: 'they live in little huts elegantly constructed with osiers, or with bark stitched together to make a hollow' (Armbruster, 1940a). Figure 27.5a shows a stylized wicker skep in the 1300s, and Figure 27.5b the last known examples in use in the 1800s.

It is generally considered that the coiled-straw

*Information supplied by Professor A.R. Birley, Vice-Chairman of the Vindolanda Trust; the text will be published by A.K. Bowman and J.D. Thomas in *The Vindolanda writing-tablets III* (London: British Museum).

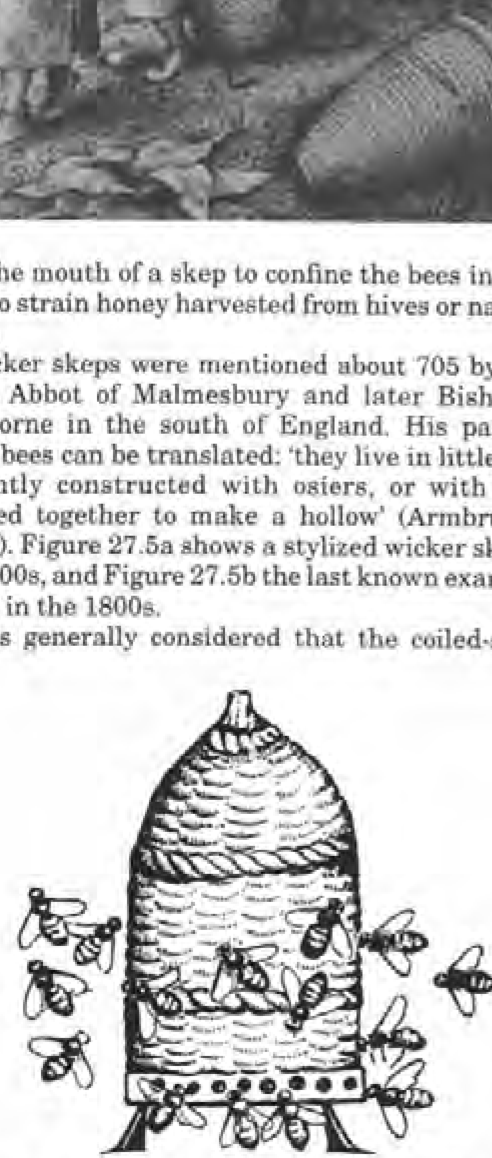


Figure 27.5a Wicker skep showing the crownpiece at the top, from the Luttrell Psalter, 1300s, in the British Museum (drawing: D. Hodges).

Figure 27.5b The last known wicker skeps in Britain, north Herefordshire, 1880s (photo: A. Watkins, Hereford City Library no. 1654). Each skep has a protective hackle, and the one on the left also a piece of sacking. On the right, both the coating of clay and cow dung, and the hackle, have partly disintegrated.

skep was introduced by Saxons at some period after about 500 when they first settled in eastern England. Use of the skep was spread westward during subsequent centuries, and it became the common traditional hive throughout Britain. Bark and log hives were occasionally recorded, for example log hives in south-east England by Keys in 1780, but I think they were never widely used.

Anglo-Saxon laws from the 700s to 1000s referred to the theft of hives. *Rectitudines Singularum Personarum*, dating from about 1125-30, set out the duties and privileges of a man who held land from his lord by virtue of his occupation, and had to work on the lord's land and do other duties. The *beo ceorle* (bee churl or peasant) and the swineherd belonged to the lowest rank of freemen. If the former had 'taxable bees' he had to pay rent, which might be in honey (Fraser, 1958). The text does not indicate what 'taxable bees' represented. Perhaps the *beo ceorle* was like a German *Zeidler* who collected honey from nests in trees, and might also have had one or more hives.

The Domesday Book was compiled by order of the first Norman King, William the Conqueror, in 1087; it described manors according to their value and resources, and detailed the payments to be made (in honey among other products), or money to be paid *in lieu* (Fraser, 1958). The term used for hive was *vascula* (small hive, perhaps of wicker) in Herefordshire. It was *vasa apum* – which Fraser (1958) equated to the larger straw skep introduced by Anglo-Saxons – in Huntingdonshire and other eastern counties. In Essex 131 out of 442 places (manors) were recorded as having hives, between 1 and 30 each. In Suffolk *rusca* was sometimes mentioned, which may designate the bark of a tree; French *ruche* is derived from it.

Among several books on husbandry written in the 1200s, *Ceo est hosebonderie* in Anglo-Norman by an unknown author gave a few indications about beekeeping practices (Fraser, 1958).

> And each hive of bees ought to yield for two hives a-year, one with another, for some yield nothing, and others three or four a-year, and in some places they are given nothing to eat all winter, and in some they are fed then, and where they are fed you can feed eight hives all winter with a gallon of honey; and if you only collect the honey every two years, you should have two gallons of honey from each hive.

The variability of honey yields from year to year (because of the changeable weather) is exemplified in an illuminated manuscript from about 1370: a 12-page calendar or almanac giving prognostications of crop yields as well as of earthquakes, thunderbolts, and so on (Crane, 1972, 1975c). Honey, represented by a tall wicker skep, is the only crop forecast for all seven years covered. In two of the years two skeps indicate 'abundant honey', and in four years four skeps signify an even greater abundance, but in the remaining year a mild winter would be followed by a wet summer, and a single over-

turned skep predicted that the bees would die (*apes morientor*).

In about 1420 Palladius' instructions in Latin were translated into English, and from the late 1500s onwards printed books gave much more information. Thomas Hill's 1568 book was based on classical writings, but William Harrison wrote about contemporary English beekeeping in *Holinshed's chronicles of England* (1586): 'Our hives are made commonlie of rie straw, and wadled about with bramble quarters but some make the same of wicker, and cast them over with claie. Wee ... set our hives somewhere on the warmest side of the house, providing that they may stand drie and without danger both of the mouse and moth.' He added that there were many more hives than formerly, and they were 'not so huge as those of the east countrie' but held only 4 or 5 pecks (36-45 litres); between 1590 and 1800 English beekeeping books recommended even smaller skeps.

Fitzherbert's *Book of husbandry* (1523) had two pages on beekeeping, and books by Southerne (1593), Butler (1609), Lawson (1618) and Levett (1634) were entirely devoted to it. Butler's book was well organized, with numbered paragraphs and a detailed contents list; it is the best on skep beekeeping in England, with detailed instructions for many different operations. Best's *Rural economy in Yorkshire in 1641* had 10 pages on bees. Fraser (1958) discussed the beekeeping books written 'out of experience', and (1942) compared details in them with those in Eldingen's 1578 book on skep beekeeping in Lower Saxony (Section 27.21). He suggested that the many similarities represented parts of a common heritage resulting from the introduction of Saxon methods into England after about 500. Eldingen wrote about afterswarms (Section 27.21); in England, they were often called casts, and names for some of them in different counties in the early 1900s included: colt, filly; spindle, wheel, hub; lob, spew; squib, bunt and chid (Betts, 1920). It is not known how old these names are.

As in Saxony, skeps were housed in lean-to shelters in eastern England – for instance in east Yorkshire (Figure 53.3c, 1618) and Essex (Purchas, 1657). In the south they were placed on stands in the open (Butler, 1609). There were differences due to the oceanic climate in England, where both Levett and Butler said that a dry summer after a moist spring gave most honey. Also hive extensions known as ekes (Section 38.31), used in England by 1593, were not mentioned by Eldingen.

Scotland

Whereas we know a good deal about skep beekeeping after around 500 in England, Wales and Ireland, this is not so in Scotland. It may be that rather few colonies could survive the winters either in skeps or in natural nests in trees (Section 9.43). Or poverty may have been too widespread, or records made have not survived – although there were centres of learning, a royal court, and monasteries which would need wax candles.

In the 1200s a wall – which still survives – was constructed with recesses to house skeps at Pluscarden Abbey in Moray (see *Wall recesses* in Section 32.23). Another such wall with recesses was built before 1530 at Ladyland, Beith, Ayrshire, and 14 have survived in the town of St Andrews, Fife; all were built before the dissolution of the monasteries in the late 1500s. Many of the walls with recesses for hives were associated with a monastery or other church property (Walker, 1988a).

In 1683 John Reid's *The Scots gard'ner* included monthly instructions for beekeepers, which are likely to represent the extent of skep beekeeping in many regions. In summary these were:

November. Stop your bees close [close the flight entrance], but leave breathing vents.
December, January. Feed weak bees, and (also in February) 'you may remove them'. [There is a similar instruction in a 1546 Welsh book; see near end of Section 27.52.]
March. Half open passages for bees ... yet you may remove them.
April. Open the door of your hives.
May, June. (concerned with swarming)
July. Prevent afterswarms, also kill drones, wasps, etc.
August. Towards the end, take bees [i.e. kill them], the lighter [hives] first; reduce flight entrances to prevent robbing.
September. Reduce entrances, destroy wasps, etc., also you may now remove bees.

The practical bee-master (1747) by Robert Maxwell, Secretary of the Highland Society, was the first Scottish beekeeping book and was therefore important, but Maxwell's knowledge of bees was out of date, and he thought the queen was male.

In the late 1700s several writers commented on the small numbers of hives in Scotland, many parishes having only 20-30. In 1795 Bonner published *A new plan for increasing the number of bee-hives in Scotland ...*, and in the 1800s beekeeping in Scotland

became more successful, with improved hives such as the Stewarton (Section 40.6).

27.52 Wales and Ireland

These countries represent the most westerly stronghold of Celtic culture, driven westward by later invaders. Ancient laws in both countries show that there was hive beekeeping.

Legends refer to the introduction of bees to Ireland. The *Martyrology of Oengus* has a gloss on the entry for St Finan Cam of Kinnitty, Co. Offaly, who lived in the 500s: 'Finan Cam brought wheat into Ireland, i.e. the full of his shoe he brought. Declan brought the rye, i.e. the full of his shoe; Modomnoc brought bees, i.e. the full of his bell; and in one ship they were brought.' Their similar shape and mouth-down position link a bell with a skep. Another legend said that St David of Wales, who also lived in the 500s, introduced bees to Ireland in the charge of St Modomnoc (or Medoc). Watson (1981) quoted a legend crediting another friend of St David, St Molaga, with taking bees to Ireland. But bees were present much earlier (Section 9.43), and wheat was grown from Neolithic times.

In both Ireland and Wales, the harvesting of combs from natural nests continued long after hives were used; it probably ceased in an area only when deforestation removed the trees that provided nest sites.

Ancient Irish and Welsh laws

These laws, based on contemporary and earlier practices, both contain passages on bees and beekeeping which Charles-Edwards and Kelly (1983) made accessible in their book *Bechbretha*, i.e. Bee judgments. This gives the text of 55 Irish judgments and a smaller number from Wales, with English translations and extensive notes and commentary. The laws of Ireland were written down in the 600s/700s, and those of Wales – which exist in one version for south Wales and two shorter versions for Gwynedd in the north – in the 1200s. Both Irish and Welsh were based on earlier material, the Welsh laws probably on those of King Hywel Dda in the mid-900s.

In both laws as many as a third of the bee judgments were concerned with the ownership and value of swarms, and they display a detailed knowledge of the sequence of swarms that could issue from a colony in the course of the summer, so swarm beekeeping (Section 27.11) was probably well established. As in England, colonies were kept in small hives so that they would swarm early and produce many later swarms; an Irish triad from the 1800s listed 'three small things which are best: a small hive, a small sheep, and a small woman'.

If a stray swarm was found on enclosed land, the man who found it was to get a quarter and the owner of the land three-quarters (Irish judgments §46, §48). If the swarm was on unenclosed land, proportions were one-third and two-thirds, or (§49) one third each to finder, land owner and church. Most judgments did not specify whether the swarm was from a hive or natural nest, but one (§47) mentioned 'a place where there are many hives owned by different people'. In a Welsh judgment (§9):

> A man who has found a swarm on someone else's land shall have from the owner of the land 4d. [pence] if he [the owner] should wish to keep the swarm. No swarm shall be worth more than 4d. before it has survived for three days of gentle breeze, namely, one day to find a place, a second to move, and a third to settle.

Irish law, like many others, dealt with theft of bees, and in general bees on enclosed land were given greater legal protection than those on unenclosed land; bees 'stolen from a garden or courtyard incur equal penalty with household goods'.

A judgment in *Bretha Étgid*, an Irish legal commentary from about the 1100s, dealt with accidental injury to bees. It referred for example to 'three hen-offences in a farmyard: soft swallowing of bees, and destruction of madder and onions' (Binchy, 1978). The owner of the bee-eating hens was fined and the payment used to recompense the beekeeper. Such behaviour by hens need not be considered impossible; in Turkey, Adsay (1950) trained chicks of common domestic poultry to eat wasps, as a method of wasp control in an apiary.

Irish and Welsh laws dealt with stinging by bees, but Welsh laws only if death resulted. Section 33.12 explains how an Irish king was deprived of his kingship after he was stung in the eye and was thereby blemished.

Only the Welsh laws referred to mead (Section 48.34).

Evidence from the Irish and Welsh languages

Table 27.5A lists terms for different swarms in Irish and Welsh languages, which belong to the Goidelic and Brythonic branches of Celtic.* Swarms were

*Breton, another Brythonic language, has bee as *gwenanen*, plural *gwenan*; swarm is *hed*, first (prime) swarm *kenthed*, first afterswarm *tarvhed* (bull swarm), and a very late small swarm (lost or tail swarm) *fosthed* (Pichon, 1990).

Table 27.5A

Some beekeeping terms in Ancient Irish and Welsh laws

Based on Charles-Edwards and Kelly (1983), Linnard (1984) and Kelly (1992).
Column 3 includes the swarm's value (in old pence) according to Welsh law.

English	*Irish*	*Welsh*
swarm	saithe	heit, heid
1st (prime) swarm	cétšaithe	kynheit (16d.)
2nd swarm (1st afterswarm), bull swarm	tarbšaithe, tánaise	tarwheit (12d.)
3rd swarm (2nd afterswarm)	iaršaithe	tryded heit (8d.)
1st swarm from 1st swarm	?mac/cétšaithe	heit gyntaf a del o'r kynheit (12d.)
1st swarm from 2nd swarm	?mac/tarbšaithe	heit gyntaf a del o'r tarwheit (8d.)
1st swarm from 3rd swarm	ua, ?mac/iarsaithe	heit gyntaf a del o'r tryded heit (4d.)
swarm later than 1 August, wing swarm		asgellheit (4d.)
Other terms		
bee	bech, beach	gwenynen
bees	belch	gwenyn
(wild) colony of bees	betham	bydaf
old colony (before swarming)		henlleu (24d.)
parent colony (after swarming)		modrydaf gwenyn (24d.)

clearly of great importance to these Celts, and beekeepers must have kept a close watch on their hives and on swarms issuing, and tried to hive even the smallest swarm. The expression *bull swarm* (Section 27.53) existed in Irish, Welsh and Breton, and was used in the Irish laws (judgments §20 and §25a gloss B; Charles-Edwards & Kelly, 1983). It is reconstructed in Common Celtic as *tarwo-satios* (*satios* = swarm). Crane and Walker (1984/85) gave modern terms for bee, swarm and hive also in Scottish and Cornish languages.

Although the laws do not make it clear what hives were used, the word *crand* (tree) for a hive in one of the Irish judgments suggests that there were log hives during or before the 600s/700s (Charles-Edwards & Kelly, 1983, p.185). The reference quoted above to Modomnoc taking 'the full of his bell' from Wales to Ireland suggests skeps. Other Irish texts used the following terms for hive (Kelly, 1990):

600s-800s	*lestar* (Welsh *llestr*) widely used for a domestic wooden vessel for liquids, also *crand*: log hive
1000s-1100s	*ce(i)s*, also *cliab*, basket: woven skep
1600s on	*corcóg* or *coirceóg*, cognate with *corca*, oats – the cereal most commonly grown in Ireland: coiled-straw skep

According to the *Book of rights* written between 1050 and 1100 (see Dillon, 1962), the King of Ulaid was entitled to '20 baskets [*cliab*] in which are bees'. These were probably woven wicker skeps.

Later traditional beekeeping in Ireland

The Annals of Ulster, which covered the period to 1131, referred in the year 951 to *bechdíbad*, 'a mortality of bees', and in 993 to 'a great mortality of people and cattle and bees' throughout all Ireland (Mac Airt & Mac Niocaill, 1983, pp. 396, 424).

By the 1200s Anglo-Normans had conquered much of Ireland, and according to Historia (1966) they introduced bee towers (also known as honey towers or honey pots), which seem to have been rather like pigeon lofts. In Co. Louth there was one at the Cistercian Monastery at Mellifont, and another at Clonmore said to have been built in the 1200s. In Co. Down there was one at Moira Castle. No more is known about them, and none has survived.

The first beekeeping book in Ireland was *Instructions for managing bees* 'drawn up and published by the Dublin Society' in 1733. It set out approved beekeeping practice at the time, which was rather similar to that in the 1500s elsewhere in the skep region. Straw skeps were recommended (Figure 27.5c). In some places the hives were made of wicker or small sallies [willow], but these did not provide enough insulation. The killing of bees with brimstone matches was 'too commonly known to be mentioned'. Driving was regarded as being to little purpose, and Dr Warder's bee-boxes (1712) discounted as 'costly and troublesome'. Swarms are highly valued. 'If you begin with ten good stocks, and the year prove favourable, so that each hive yield one prime swarm, and a cast [afterswarm] besides, and if you put two

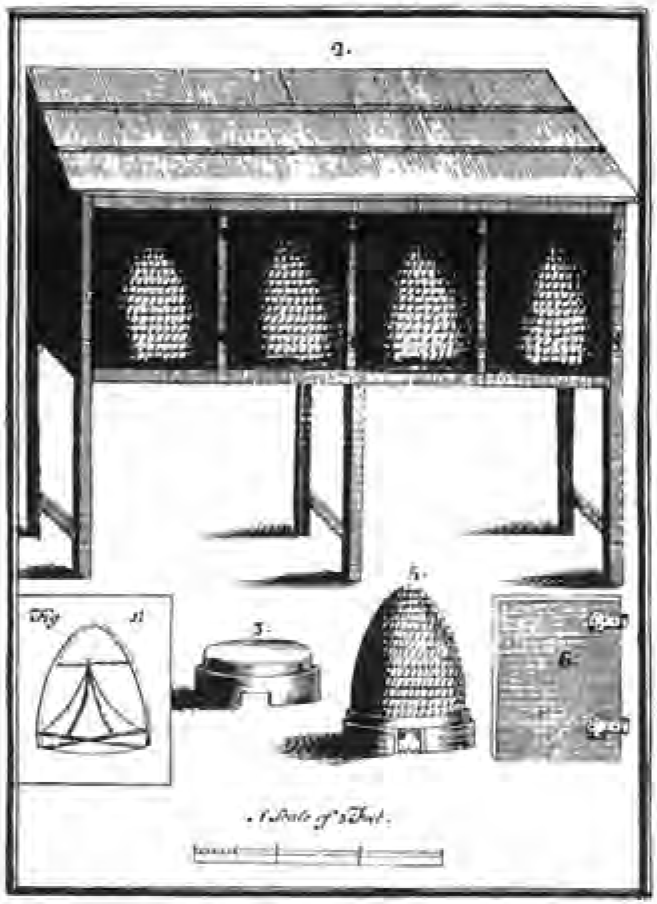


Figure 27.5c Shelter for 4 skeps and (6) one of the doors, with details of a skep (Dublin Society, 1733). A 'wooden hoop' (3) protects the bottom ring of straw, and the inset shows an arrangement of sticks of green ash and sally, designed by an 'ingenious Gentleman' to support the combs. It does not interfere with harvesting since the bees are killed beforehand.

casts into one hive, then you will have 25 good stocks at the end of the first year ...'.

A statistical and political account of Ireland (Wakefield, 1812) reported that the Dublin Society had offered a premium for the preservation of bees in winter, and the wording indicates that beekeepers used ekes, which are explained in Section 38.31.

Later traditional beekeeping in Wales

A record for 1256/57 in Abergavenny referred to 4 gallons of honey (25 kg) from a 'hive destroyed', and such a hive must have had a capacity of 40 litres or more (Crane & Walker, 1984/85). The first book printed in Welsh, in 1546, was *Yn y lhyvyr hwnn*, a month-by-month gardening calendar; its only beekeeping instruction was on the January page: *symyd dy wenyn* (move your bees). This referred to moving a hive to a new site, which was best done when the bees were inactive; in the flying season they might have difficulty homing to the new hive site. The operation was considered important, and Butler's 1609 English book devoted a Chapter to it.

John Keys (1796), who lived near Pembroke, said: 'Straw is the best material for hives ... and also generally the easiest to be procured. Where it is not so, rushes, wicker-work plastered over, or sedges, must be substituted.' He referred to log hives when writing in south-east England in 1780, but not when writing in Wales.

In 1797 beekeeping still aimed at increasing the number of colonies by encouraging swarms. The Wrexham Agricultural Society offered a premium of 3 guineas to the cottager who 'before 1 September 1797, shall raise the greatest number of stocks or hives of bees ...', and Societies elsewhere offered similar prizes (Crane & Walker, 1984/85). M.R. Williams (1972) provided some further details of the history of beekeeping in Wales.

27.53 When did hive beekeeping start in Britain and Ireland?

The earliest detailed information is contained in the Celtic laws of Ireland and Wales (Section 27.52). Hive beekeeping must have reached Ireland and Wales well before these laws came into being (below), and they existed in written form by the 600s/700s and in the 1200s, respectively. To Charles-Edwards and Kelly (1983): 'Celtic-speaking people who came to Ireland brought with them some knowledge of beekeeping.' Celts were Iron Age people who spread out from central Europe across much of the continent. They probably reached Ireland and Britain between 1000 and 500 BC (e.g. Stevenson, 1983), and perhaps some of them introduced wicker skeps. A first wave of them (Goidelic speakers) settled in Ireland and then Scotland, and that a second wave (Brythonic-speakers) reached England, and thence Wales and Cornwall – and Brittany in France.

Secondly, the existence of a term for 'bull swarm' in Irish, Welsh and Breton (Table 27.5A and text) also suggests that Celts who were the forebears of Irish and Welsh peoples had kept bees in continental Europe, and brought a knowledge of it to these island countries before 500 BC. The term 'bull swarm' would have had a significance only for people familiar with hives of bees at swarming time. An afterswarm (which has a virgin queen) issues from a colony some days after a prime swarm has left, and many drones

are also flying during the season when virgin queens fly out. A drone is larger than a worker and makes a louder lower-pitched noise in flight, so could have been regarded as a 'bull bee'.

Thirdly, Charles-Edwards and Kelly (1983) pointed out also that the Irish bee judgments contained no Latin loan words relating to bees, so their beekeeping vocabulary was established before AD 430 when Christianity arrived, with its extensive use of Latin.

There is no evidence that Roman-type beekeeping was practised, and only one slight Roman beekeeping reference is known (Section 27.51).

Note added in proof

In *Abeilles & Fleurs* (593): 104 (1999), C. and J. Courrent published a photograph of an earthenware vessel excavated in the fortified Celtic town of Ensérune close to Narbonne in the extreme south of France, dated to the 200s BC. From its shape and size, and the presence of a possible flight entrance at the mouth end, it could have been an upright hive; there is a 28-cm central hole in the other end (for removing honey combs?), which has a separate cover.

28

Traditional Hive Beekeeping in Africa South of the Sahara

28.1 The general picture

Almost all of Africa south of the Sahara is in the tropics. In contrast to parts of North Africa, we have no records or artefacts from Ancient times that explain the beekeeping in this large region, and we know almost nothing of its chronology. However, in many countries traditional beekeeping and hive making continued into the 1900s and have been studied and recorded.

The map in Figure 28.1a indicates the different regions dealt with in the Sections of this Chapter. The dry belt south of the Sahara and the wooded grasslands of East Africa are in Sections 28.2 and 28.3, the west African coast from Senegal to Nigeria in 28.4, Equatorial Africa with its extensive rain forests in 28.5, and Southern Africa and islands to the east in 28.6 and 28.7. Section 28.8 discusses deductions that can be made about the past history of hive beekeeping in the region.

The hive most commonly recorded throughout

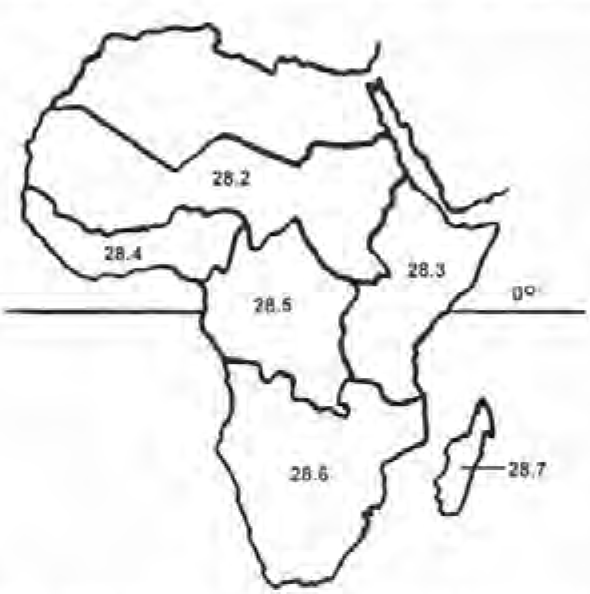


Figure 28.1a Map of Africa showing the regions discussed in the Sections of Chapter 28.

tropical Africa was a horizontal cylinder. In the dry north it was made of earth materials, and in less dry regions of selected plant materials. Examples are shown in Seyffert's 1930 map (Figure 28.1b), and we now know what hives were used in some of the regions he left blank; some additional material has been published, and since 1950 many reports on individual areas have been written for aid agencies concerned to make beekeeping more productive. Most hives reported were made from logs, bark, plant fibres such as grass (which might be woven), or strong leaves. Where none of these materials was available, hives were round clay pots like those used for household purposes, or round gourds. Many log or bark hives could be opened at both ends, like Egyptian hives, but some – especially woven hives – were permanently closed at one end as in Figure 28.4b,B.

Although in recent times hives existed in great variety, and many showed superb craftsmanship, there was less ingenuity in bee management than in many other regions, and beekeeping usually consisted of little more than preparing hives and harvesting combs from them. A new hive was treated to give the interior a scent believed to be attractive to bees, and put in position to await occupation by a swarm. The treatment might include burning beeswax in the hive, or rubbing the interior with sweet-smelling herbs such as sage (*Salvia*) or basil (*Ocimum*); propolis might be smeared near the entrance. Honey combs were harvested at a season governed by experience or custom. The more advanced beekeepers left brood combs intact so that the colony lived on, but others removed all combs; unless the bees survived and reoccupied the hive, the colony perished. A few beekeepers knew how to ensure that combs were built across – or along – their hives (end of Section 38.22).

In most parts of tropical Africa hives were sited in trees (Figures 28.1c, 28.1d, 32.4a). Diurnal temperature variations were less there than at ground level, and flying swarms were more likely to enter hives. The ratel or honey badger (Section 5.3) would destroy

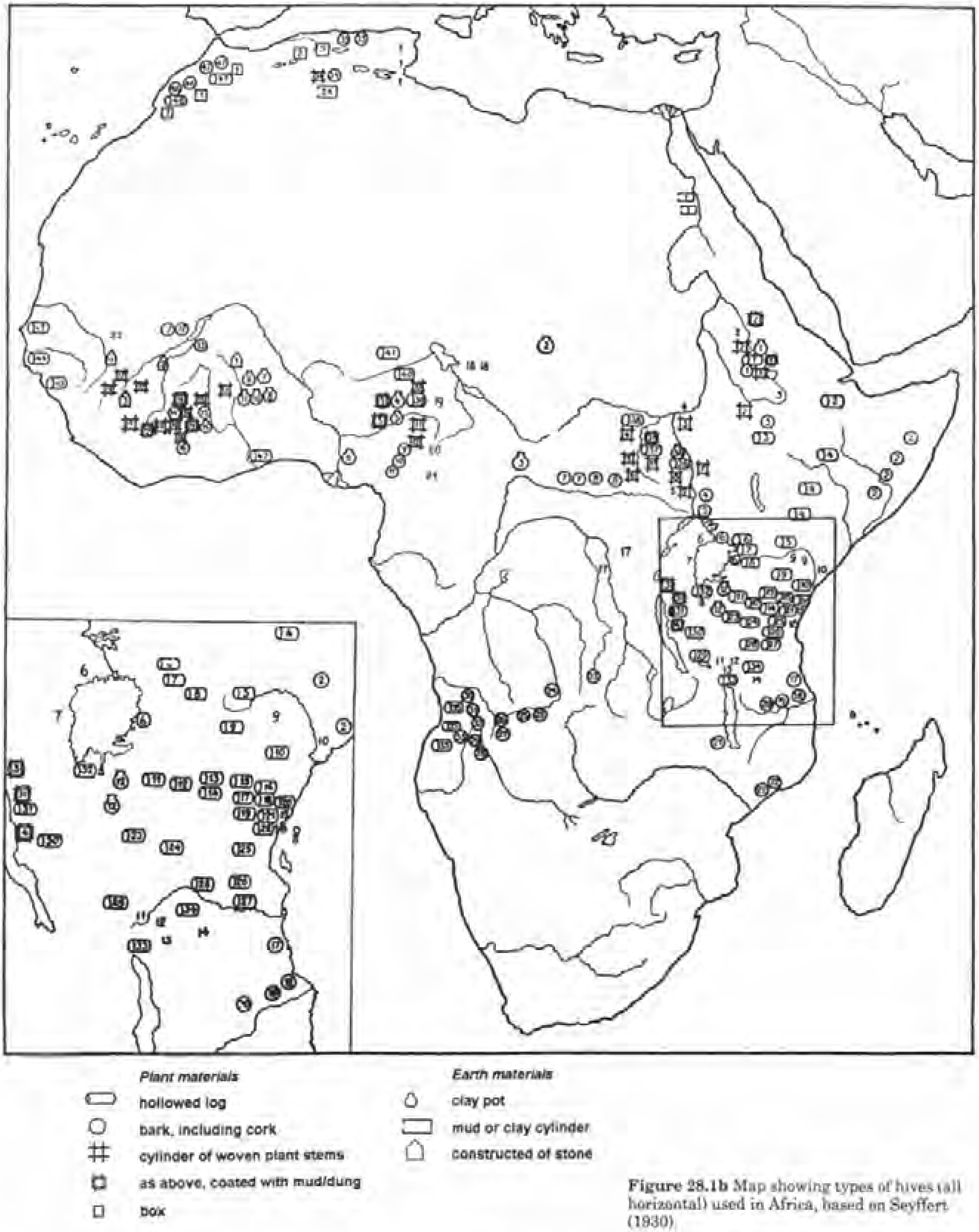


Figure 28.1b Map showing types of hives (all horizontal) used in Africa, based on Seyffert (1930).

Figure 28.1c Beekeeper with honey barrel, watching bees working at his bark hive hung from a tree branch by a forked stick (photo: Kenya Information Service).

any hive it could reach, and placing hives in an erect, smooth-barked tree afforded some protection. Beekeepers might also pile thorn bushes round the base of the tree (F.G. Smith, 1960). The hives were usually hung from a branch by a hooked stick, or secured in a fork between branches. Throughout the region there was a traditional prohibition against a beekeeper placing hives in a tree already occupied by another man's hives.

In Africa as elsewhere, the number of colonies that could live in an area might be limited by the number of nest sites (including hives), or by the amount of bee forage. In Kenya in 1985 Mwangi recorded that on average 98% of traditional hives were occupied in cultivated areas with plenty of forage, but only 36% in the arid north-west where forage was scarce.

Swarms of tropical African bees are of two types. In addition to reproductive swarming in which a swarm leaves with the old queen to find a nest site elsewhere, the whole colony may fly out in an absconding swarm when forage is dwindling, to seek a nest site where flowering is about to start (Section 4.5). In extreme conditions the rate of absconding may be so high that most hives are empty at certain times of the year. Absconding can also occur as a result of disturbance.

Some beekeeping practices differed in different areas according to conditions and the customs of the people. For instance honey combs were usually harvested from hives *in situ* but, where the structure of the tree allowed it, each hive might be lowered to the ground before being opened for harvesting, as in Figure 28.6a. This was not possible with a tree such as *Acacia* which had many lower branches. Figure 28.1d(C) shows a platform constructed in the tree, close to a hive.

The native hive bee in the whole of Africa is the honey bee *Apis mellifera*; races in the different regions are indicated in each Section. Most bees are more readily alerted to sting than European honey bees; for instance if a colony has recently been dis-

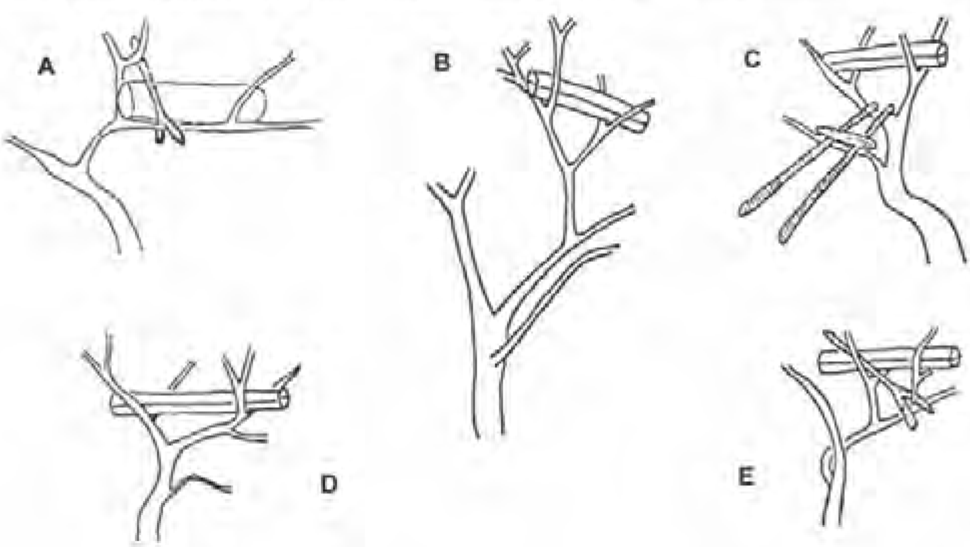


Figure 28.1d Some ways in which the Tongwe in western Tanzania fixed hives in different trees (Takeda, 1976). See p. 263.

A, B, C *Brachystegia boehmii*
D *Diospyros kirkii*
E *Pseudolachnostylis maprouneifolia*

turbed, the bees may fly out and sting *en masse* when a beekeeper opens the hive. Harvesting was therefore often done at night (Paterson, 1989) when bees were less active and could not see to fly, as with *A. dorsata* in Asia (Section 15.23). In high areas that were damp and cold – for instance in Kenya, on Mount Elgon at 3000 m and the Mau escarpment at 2500-3000 m – it was usually done in the afternoon. Bees at these altitudes (where temperatures are lower) are in general less likely to sting than those on the plains.

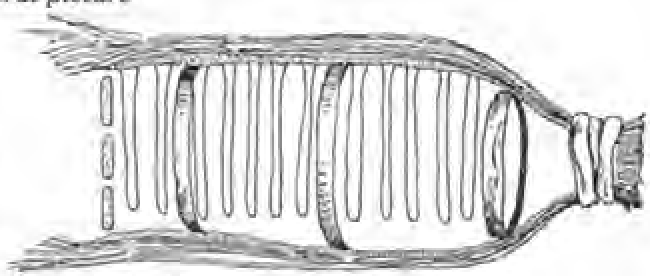


Figure 28.2a Section through bark hive used in Mali, 1986 (drawing: R. Darchen). The hive (length 132 cm, diameter 32 cm) is kept in shape by three wooden hoops, and protected by plant stems bound round it. Flight entrance holes have been made in the removable closure of baked clay on the left.

Early references to bees and honey

There were very few written records about the countryside of Africa south of the Sahara until Europeans penetrated inland, but Section 8.12 refers to early records for West Africa made by Arab traders. Seyffert's 1930 book on bees and honey in the social life of Africans is a valuable source of records written between 1500 and 1900, which indicate a great abundance of bees and honey. For instance:

1576 Alvarez on Ethiopia: 'The whole land is overflowing with honey'.
1602 The earliest known published depiction of African honey bees (a nest on a tree) is from Guinea between Senegal and Ivory Coast; it was in a book by Pieter de Marees (Amsterdam, 1602) and was reproduced by Pager (1976b).
1625 Samuel Braun on Angola: 'There is much honey in the forests, and the bees make honey and wax from many sweet plants.'
1630 Artus in Guinea: 'There are many bees here.'
1670 Dapper in the north-east: 'very many bees and an abundance of honey.'
1678 Barbot in West Africa: 'The forests, especially towards Gambia, are full of bees.'
1886 Johnston in Equatorial Africa: 'Honey is produced in immense quantities.'

Major uses of honey and beeswax in tropical Africa are dealt with elsewhere: the fermentation of honey to make alcoholic drinks in Section 48.4, and the supply of beeswax to the world market in Section 46.82.

28.2 The Sahel bordering the Sahara

The bees in this region are *Apis mellifera jemenitica* in the east, and *A. m. adansonii* from Niger westward (Ruttner, 1988).

In Ancient times, Nubia (Cush) adjoined Egypt to the south and extended along the Nile valley from Aswan to Khartoum (now in Sudan) and over neighbouring deserts. It had many interactions with Ancient Egypt, and its rulers governed Egypt for a period around 800 BC. So knowledge of hive beekeeping could well have reached what is now Sudan from Ancient Egypt.

Recent traditional hives in Sudan were cylinders 2 m long, made from leaves of the doum palm (*Hyphaena thebaica*) and hung in trees (Rashad & El-Sarrag, 1978). The ends were closed with a plug of leaf fibres, and midway along the hive a rectangular hole was made as a flight entrance. Garcia and Gasma (1986) described a hive made by rolling a woven grass mat into a cylinder which was used in Darfur, a relatively good honey-producing area in western Sudan. In southern Sudan, many of the peoples studied by Brown (1984) preferred a hollowed log (1 to 2 m long) for a hive, because it was durable – 'so durable that a son can inherit it'. But Jo-Lou and Belinda-Bor peoples made cylindrical hives of bamboo, and Bai and Belinda-Bor used clay pots.

In the dry Sahel west of Sudan, hives in Chad included a baked round clay pot on its side, a hollow log and a bark hive (Gadbin, 1976). Figure 28.2a shows a bark hive in Mali, sometimes described as conical. Because of the construction method, the back end was pointed and permanently closed, and honey combs were removed from the front end which contained flight holes. In Niger, hives up to 1 m long and 25-30 cm across were made of plant stems woven diagonally along the hive (Bohrer, 1986; Himsel, 1991); compare Figure 28.4b(B). In the Gaya region the hives were 'conical'; in Makalondi and Matameye they were cylindrical, and combs were taken by removing the closure at the back.

Aid workers in Burkina Faso described woven hives coated on the interior with a mixture of cow dung and earth from a termites' nest, and treated with smoke from a fire of suitably scented herbs.

28.3 East Africa

In this region south and east of Sudan, the bees are mainly *A. m. scutellata*, with *A. m. monticola* on high land and *A. m. litorea* on the coast (Ruttner, 1988). In many areas the rainfall was high enough to produce abundant bee forage, and also mature trees from which large, durable log or bark hives could be made. This area – now Ethiopia, Somalia, Kenya, Uganda and Tanzania – may have had the richest beekeeping tradition in tropical Africa, and several of its peoples developed a high standard of beekeeping.

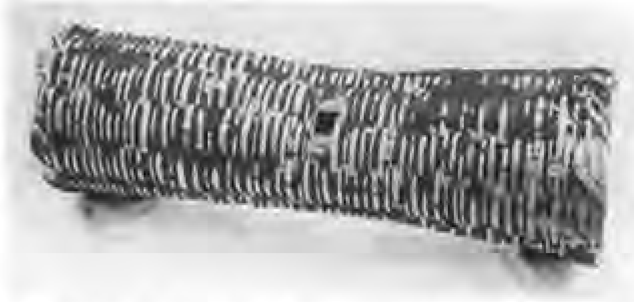


Figure 28.3a Woven hive of split cane, smaller in the middle than at the ends, Ethiopia, 1972 (IBRA Collection H72/14).

Ethiopia, Eritrea and Somalia

The earliest account found of beekeeping in Ethiopia is by Julien (1918). He saw horizontal cylindrical hives 50-120 cm long and 20-35 cm across, made of wood, bark, woven plant stems or sun-dried mud. The ends had removable closures, and flight holes might be at one end or midway along the hive. Hives were protected by a layer of straw or similar material, and were supported on two forked sticks, or on shelves against the house wall. They had not changed much by the 1970s, when I saw traditional cylindrical hives made of *Cordia africana* logs and, in Gojam, of woven reeds or cane. Many were large, and longer than a man's arm 'so that when harvesting honey he left the last few combs behind'. At 3300 m in the High Simien, J.H.P. Rea found a primitive hive in 1972; it was made of a mixture of mud and cow dung, rather egg-shaped, with the flight hole at the narrower end. The wider end was broken off to harvest honey, and probably plastered on again afterwards.

Griaule (1928) described woven cane hives wider at the back (from which honey combs were taken) than at the front. Up to forty were kept behind a dwelling house, in a shelter; in warm regions this had no walls, but in higher colder areas it was enclosed.

Beekeepers sometimes used large hives which could be reduced in size – for instance by pushing in one or both end closures – when colonies became small in a dry dearth season. As an alternative, the Ethiopian cane hive shown in Figure 28.3a has a shape described by the Roman author Varro as 'most narrow in the middle', so that a small colony could prosper there (Section 24.1).

In most of western and southern Ethiopia there was an ample rainfall, and bees did well. They were important to the Majangir people, who fermented much honey into an alcoholic drink and sold the surplus to neighbouring peoples. Although some other peoples killed the bees when they harvested honey (Mammo, 1976), the Majangir looked after the bees well, in hollowed logs about 150 cm long and 30 cm across. As well as owning the hives he made, a man had rights over the trees in which he kept them, and also over the area round his trees – 'his wilderness'. This might be 40 km in diameter, and was at least 400 m from an area occupied by any other beekeeper. A beekeeper's rights were relatively permanent so long as he attended to his hives and bees, but not if he moved too far away to do this. His children could inherit the hives provided they continued to live near enough to them. Hives were rarely sold, and sites never (Stauder, 1971).

Baria and Baza peoples in Eritrea practised beekeeping, and Fougères (1902) illustrated a log hive supported on two upright forked sticks, but in the dry Sahel region honey was collected from natural nests in the rocks. In 1902 Dufour saw many bees in Djibouti, and a pot hive placed in a tree, so he rejected a previous report that this was a useless area for beekeeping. In Somalia Paterson (1982) found a small amount of beekeeping by settled people who practised some cultivation. They used log hives that could be opened at either end, supported near the ground on posts. When harvesting, they made an effort to leave brood comb intact. One beekeeper in the Janaale area was accustomed to capture a swarm, put the queen in a cage made from small pieces of scrap metal with holes punched in it, and take her – with the bees in a net bag – to a prospective purchaser. Queen cages were also used in Ethiopia, as in Figure 28.3b: A, shown closed, was made of plant stems kept in position by two rings; B, still open, was of split bamboo, and would be closed by a knot of plant fibres (Griaule, 1928). In Eritrea Fougères saw a rather similar cage (C) in 1902. Fichtl (1995b) found cages of grass fibre, and in 1996 Arnon Dag told me he saw them of straws stuck into end-pieces of leather.

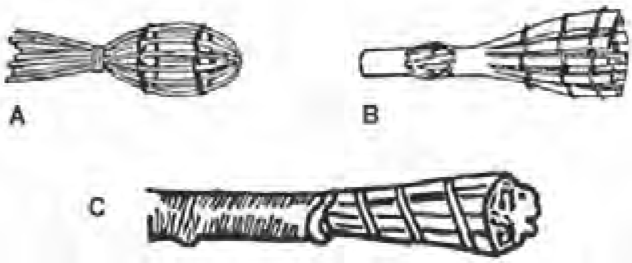


Figure 28.3b Queen cages: A and B, Ethiopia; C, Eritrea (Griaule, 1928; Fougères, 1902). See text.

Kenya, Tanzania and Uganda

Traditional beekeeping was an important part of the life of many peoples in Kenya, which lies on the equator, and in Tanzania. In many regions large trees provided material for log hives up to 50 cm across, and they were made 1 to 1.5 m long, or occasionally 2 m. Southern Tanzania has much *miombo*, elevated woodland characterized by *Brachystegia* and *Julbernardia* species. The interior of a suitable log might be chipped away from each end in turn (Harris, 1932), and Figure 28.3c shows the work in action in Kenya. The ends of the finished hive were closed with suitable plugs of wood, or grass coils. Several flight holes were made in one end as in Figure 28.4b(A), or one halfway along the side as in Figure 28.3a. Alternatively, the Pokot in the Rift Valley made a 'window' halfway along the hive through which combs were harvested.

Cylindrical bark hives were also made from large trees. In one type the outer bark of a *Brachystegia* was removed as in Figure 28.3d (which killed the tree), and formed into a cylinder by securing the edges with wooden pegs as in Figure 28.3e; there is another example in Figure 28.6a. End closures were made of bark. Also, the inner bark of *Brachystegia* is soft and pliable when moist, and two pieces were sewn together with bark cord to make a wider cylinder, closed at each end with a piece of bark. The hive was protected by a carefully constructed outer layer of grass. In the west of Tanzania the Watussi used a cylinder of woven grass, and in Bukoba a cylindrical structure of parallel bamboo sticks was supported by circular end closures of wood, and covered with a thick layer of banana leaves (Harris, 1932).

Figure 32.4a shows hives hanging in a tree in Kenya. Beekeeping by the Embu, Mbeere and Meru on the slopes of Mount Kenya has been much studied (Bernardini, 1959; Mwaniki, 1970; Brokensha & Riley, 1971; Brokensha *et al.*, 1972). Jackson (1992) describe beekeeping in the SW Mau and Trans-Mara Forest Reserves. Ichikawa (1980) reported on the Suiei Dorobo. Nightingale (1983) recorded his recollections of beekeeping by about 15 peoples in Kenya, for instance Dorobo, Kalenjin including Tugen, Kikuyu and Pokot. Peoples studied in Tanzania include: in the south, Ngindo (Crosse-Upcott, 1956); in the west, the Tongwe (Takeda, 1976) and the Sitete on Mount Sisaga (Kakeya, 1976); and in the north the Wameru (Chandler, 1975b) and Babati (Ntenga & Mugongo, 1991, who published many illustrations). Figure 28.1d shows Tongwe hives and ways in which they were fixed in trees. Hive A, about 80 cm long and 30 to 40 cm across, was made from inner bark of *B. boehmii*. Hives B-E were the usual type, about 150 cm long and 30 cm in diameter, made from a log split in two. An extra supporting pole was needed to keep hives A and E in place. In C a platform was made for the beekeeper to stand on. The Babati say that the length of the hive 'is measured by the length of one and one-half forearms'. In trees in the *miombo*, some hives were hung almost upright. Harris (1932) included a map showing centres of beeswax production in the drier eastern part of Tanzania, which he regarded as indicating hive beekeeping.

Figure 28.3c Hive being made by chipping away the inside of a log, Tharaka, Kenya, 1967 (photo: E. Crane).

Figure 28.3d Bark has been cut from a large tree in the *miombo* to make a hive, Mozambique (Guy, 1972).

Figure 28.3e Bark hive to be used horizontally, showing pegs, and bark end closures, Southern Province, Tanganyika, 1951 (photo: F.G. Smith).

Below are a few extracts from Brokensha's (1982) collection of songs sung by Mbeere beekeepers when they were doing beekeeping work on Mount Kenya.

Putting out a new hive
Bees! Bees! Inhabit my father's bee hive.

Attending to hives
You early morning walkers who go out at dawn,
When you drink, give some beer to a son of the beekeeper -
He collects the bee hive lids when they fall!

When a hive gets broken
It is very far in the valley of elephants.
I was told by a broken hive 'Don't throw me about!'
Go and keep me on a tree in the valley of the elephants.
A broken bee hive screams like a weak person,
And a new hive roars like a lion.

Beekeeping was important throughout Uganda, and especially in three areas (Roberts, 1971). In Teso in the east, the Itesot of Nile-Hamitic origin used hollowed logs. In Kigezi in the extreme south-west, the Bantu-speaking Bakiga and Banyarwanda peoples used cylinders of woven grass, papyrus or cane, which were sometimes made wider towards the back end from where the honey was harvested. Peoples of Sudanic origin in West Nile in north-west Uganda used a variety of hives including hollow logs, baskets and disused cooking pots. Figure 28.3f shows a log hive. A beekeeper I met in 1984 in the Ruwenzori mountains in western Uganda kept 28 woven horizontal hives in a bee house. Hives in the open were harvested at night, with the aid of a smoker carefully constructed from layers of different plants materials rolled into a cylinder.

Figure 28.3f Log hive in a tree in Uganda, c. 1990 (photo: J. Corner).

28.4 West African coast

The coastal region between Senegal and Nigeria, where the honey bees are *A. m. adansonii* (Ruttner, 1988), now includes nine other countries, but reports cited by Crane (1978a, Part 2) do not suggest substantial variations between them.

Lewicki and Johnson (1974) studied Arab writings on West African food in the Middle Ages. They found many references to abundant honey and its widespread use (Section 8.12), but none to hive beekeeping, although they thought that this might have provided some of the honey.

Figure 28.4a shows hives in Senegal, only two of which have features not already described. Hive C was, unusually, suspended *upright* by the hanging stick shown. Hive E was suspended by a rope attached to an iron rod (indicated by a broken line) incorporated in the hive; this may be a recent innovation. In Ivory Coast, INADES (1988) referred to hives of bark, and others of slats of wood supported by hoops. In one part of Guinea-Bissau free-nesting colonies of bees were traditionally kept inside dwelling houses (end of Section 16.4).

Adjare (1989) distinguished three regions in Ghana. In the north, round clay pots, gourds and grass hives were used, and in Central Region – unusually – pot hives were placed on the ground; in both regions bees were killed when honey was harvested. In Volta Region beekeeping was more advanced. When a royal palm died and termites had eaten out the soft centre, the hollow trunk was cut into lengths of about 1 m for use as hives, and these were placed horizontally in trees known to be fire resistant. When honey was harvested, certain plants were used to pacify the bees (Table 8.6B), and the colony was not killed.

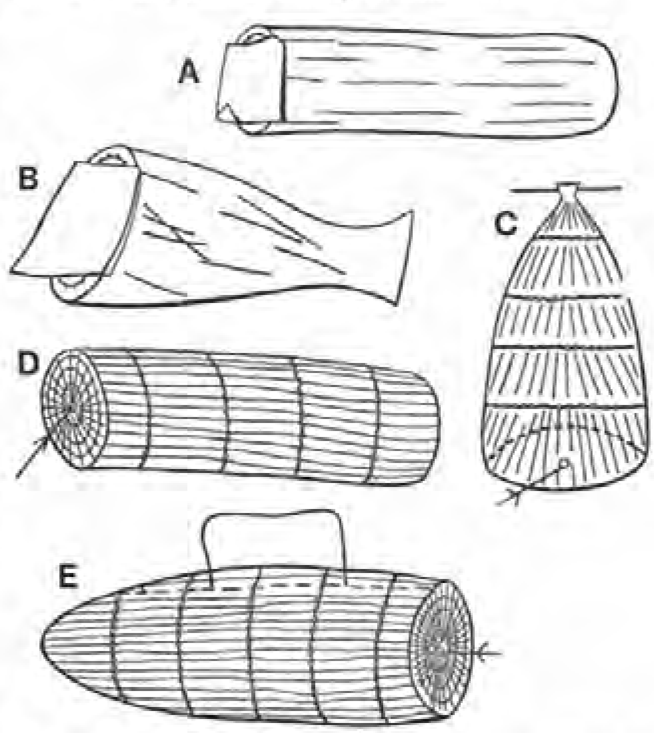


Figure 28.4a Some hives used in Senegal (Ndiaye, 1976). *Log hives*: **A** cylindrical; **B** conical; both in Wolof. *Hives made from plant stems* (arrows show flight holes): **C** skep-shaped used upright, and **D** cylindrical used horizontally, both in Serere; **E** conical used horizontally, in Diola.

Recent traditional beekeeping in Nigeria was described in the north by Taylor (1942, Zaria) and Jessen (1967), in the west by Attfield (1967), and among the Tiv along the Benue river by Ayoade (1977). Mutsaers (1993) gave details of various hives, and two are shown in Figure 28.4b; some others were oval or round, for instance a gourd, cooking pot or woven basket; honey was usually harvested from the back of the hive, opposite the flight entrance. Harvesting was done after dark, on moonless nights or when the moon was waning, in the belief that during a waxing moon bees consume honey rather than store it. Some beekeepers left brood combs intact, but others removed and discarded them. In Benin to the west, Dufour (1902) found only pot hives, placed in trees in the hope that swarms would occupy them.

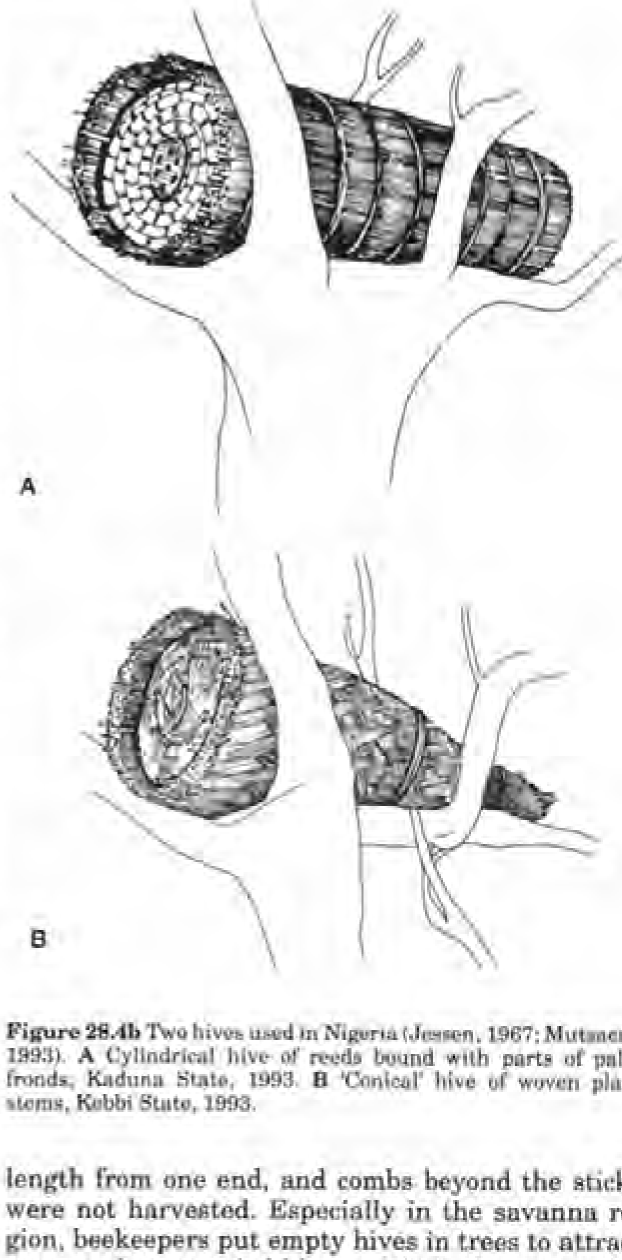


Figure 28.4b Two hives used in Nigeria (Jessen, 1967; Mutsaers, 1993). **A** Cylindrical hive of reeds bound with parts of palm fronds, Kaduna State, 1993. **B** 'Conical' hive of woven plant stems, Kebbi State, 1993.

28.5 Equatorial Africa

Equatorial Africa, east and south of Nigeria, is largely occupied by the Congo basin with much rain forest, and is crossed by the equator. The bees are mainly *A. m. scutellata* in the east and *A. m. adansonii* nearer the west coast (Ruttner, 1988). By far the largest present country is Zaire, with *mikondo* (*miombo*) covering part of the south. Many hives used recently were similar to those of log and bark used in East Africa, and others were made from bamboo, or papyrus, or coiled straw protected by cow dung and banana leaves. Hives might be 1-1.2 m long and 20-30 cm across; some were made larger at the back – where honey combs were harvested – than the front. Harvesting was stopped as soon as a comb with brood was seen. Dubois and Collart (1950) published a detailed description of the traditional beekeeping in what are now Zaire, Rwanda and Burundi. Reports on development programmes by Bauduin (1956) and Vandeghinste (1989) also described it in Rwanda. A map by Miracle (1967) shows that hive beekeeping and honey hunting were done by Pygmies in separate areas in the rain forests.

Beekeeping in Congo farther west was similar to that in Zaire and Cameroon. In North-West Province of Cameroon (Paterson, 1989; Godlove, 1989) hives were made from logs, or constructed rather elaborately from local plant materials. Roots of *ntoh*, a local fig, were twisted together to form two hoops; these supported longitudinal raffia or bamboo slats to form a cylinder, and grass was bound on the outside as a protection. Three or four sticks were pushed in across the hive, slightly less than one-third of the length from one end, and combs beyond the sticks were not harvested. Especially in the savanna region, beekeepers put empty hives in trees to attract swarms, but occupied hives might be kept near the ground, supported on two upright forked sticks; this was also done in Zaire.

In the Central African Republic hives were also made from lengths from split bamboo or other plant stems, kept in place by rings of wood on the inside, and protected by an outer layer of plant materials. The interior was coated with a mixture of mud and dung. A report by the International Trade Centre (1979) included further information.

28.6 Southern Africa

The bees are *A. m. scutellata* and in the extreme south, *A. m. capensis* (Ruttner, 1988). *Miombo* (as in Tanzania, Section 28.3) covered all or most of Zimbabwe, Zambia and Malawi, and parts of Angola and Mozambique.

Livingstone (1863) saw hives in Angola and western Zambia in 1855/56:

> The bees abound, and so does honey ... in travelling yesterday through dense forest, many hives of bees were observed. There was a piece of tree, about 10 or 15 inches in diameter and about 5 feet long. Some were made of bark, and a covering put on each end with holes for the bees to enter. They are suspended horizontally in trees. Some, however, are put thus on a stump [his drawing shows the hive quite close to the ground]. ... Hives for bees are seen on the trees close to the path, and no one thinks of disturbing them except the owner. All fear the medicine that has been placed there.

A somewhat similar belief was fostered in Madagascar (Section 28.7).

In Angola traditional beekeeping was done in the north (the *miombo* does not extend to the south), by people whose main livelihood recently was from the sale of beeswax (Portugal Araújo, 1956). The head of a household had certain rights over 1000 to 5000 hectares of land, which might contain only 10-20 hives but had many natural nests of bees in trees, rocks and termite nests. He would visit his area to harvest combs two or more times a year or, it was said, when the growth of his finger nails told him it was time to go. Harvesting was done at sunset, when bees were believed to be least likely to attack. Much smoke was used, and all combs were taken; some from natural nests were 1.5 m tall (long). Portugal Araújo thought that bees sting black skin much more than white skin, but this was not a universal belief.

In Zambia, the most common hive was made of bark held together by pegs, as in Figure 28.3e; Clauss reckoned in 1991 that 95% of hives in NW Province were of this type. Others were of long wooden slats kept in place by hoops, or calabashes. Hives were made attractive to swarms by rubbing or smoking the interior with selected herbs, and sometimes by applying propolis near the flight entrance. Many details of hives and their operation in the late 1900s were given by Silberrad (1976), Clauss and Clauss (1991) and Clauss (1992). Figure 28.6a shows a hive being lowered to the ground for harvesting.

Figure 28.6a Bark hive being lowered for harvesting, Mazabuku, Zambia, 1963 (photo: P. Papadopoulo). The bee veils and suits are modern.

Zimbabwe, south of Zambia, is separated from it by the Zambesi River. In 1886 Thomas Baines said that the Sapetané people near Victoria Falls (on the River) used bark hives, but that these were not seen south of the Zambesi. In 1993, *Bee Line* gave the number of bark and log hives in Zimbabwe as about 40,000, owned by 8000 beekeepers. Mukwaira (1977) found that bark hives were the more common, usually made from *Julbernardia globifera* and species of *Brachystegia*, one and a half times the length of the beekeeper's arm. If a log for a hive was found hollow, it was worked and smoothed on the inside, but a solid log was split in two and gouged out; this was sometimes done in Kenya and Tanzania. Hives were hung at a height of about 10 m, in a tall tree or on a boulder, and lowered to the ground for harvesting. A smoker was made from a tied bundle of smouldering grass, with green leaves from 'tranquillizing' plants such as those at the end of Table 8.6A. When a household clay pot became cracked, it would be hung in a tree to attract swarms, its mouth being plugged with a twist

of fibre and grass. Mukwaira (1977) attributed this use of clay pots to the observation that bees occupied pots that had been placed on a grave, originally containing food for the deceased in the afterlife.

Traditional beekeeping was probably not widespread in Malawi, since in 1963 Sheriff reported 'getting honey hunters to change over to the use of primitive hives'. In Mozambique to the east, Guy (1971b) found that it existed only within the *miombo* in the north. Most hives were of bark, which could be taken from *Brachystegia boehmii* at any time of year, or from *B. spiciformis* and *Julbernardia globifera* at the height of the rainy season around February. Flaps of bark were bent over the ends of the hive to close it.

Most of Botswana consists of dry steppe land, including the Kalahari desert, which is still inhabited by San people (Bushmen), hunter-gatherers who valued the honey they got from natural nests. Hive beekeeping was not started until it was taught there in recent decades (Clauss, 1983). In Namibia beekeeping was very rare.

Much of South Africa has a subtropical climate. There are records of natural nests and their use by man (Chapter 8), but I have found none of past traditional hive beekeeping by either native peoples or Europeans who made permanent settlements from 1652 onwards. Seyffert's 1930 map (Figure 28.1b) showed no hives south of the Limpopo, and Guy (1970) referred to this river as the southern limit of traditional hive beekeeping; he quoted from H.T. Bryant (in *The Zulu people*, 1949), who 'never came across any example of Zulu beekeeping' and added that Tonga in North Zululand got no further than tending nests, and Bantu-speaking people had even less understanding of bees. Anderson (1994) knew of no culture of beekeeping among any native peoples of South Africa, including the Khoi (Hottentot) and San.

28.7 Madagascar and other islands

Madagascar was settled by peoples from islands now in Indonesia, and later by others from Africa. Its traditional beekeeping had some features not found in African cultures. The bees native to Madagascar are *A. m. unicolor*, which are more gentle than those on the mainland, and the large bee predators of mainland Africa are absent. Hives could therefore be kept on the ground, and were placed in trees only to attract swarms. Fert (1985) described the collection of bees from nests in the forest, for sale in the market to people who would keep them in a pot or box in their garden.

Robert Drury (1687-*c.* 1736), a Londoner who was captured on a voyage home from the East Indies, lived as a slave in Madagascar for fifteen years. His *Journal*, published in 1729, described how he improved his condition by keeping bees. He described making hives – in which he 'took a particular delight' – from logs about a yard long, split in half and gouged out with a hatchet, then bound up leaving 'a hole at the bottom for them [bees] to enter'. Theft of honey from hives was very common, and Drury related a long story in which a sorcerer prevented one beekeeper's honey being stolen, by saying that the honey in his hives was poisonous.

In 1922 Vallette found log hives about the same size as Drury's, with flight holes in an end closure. In wooded country, hives were placed on the ground, but in forests this position was too damp. When harvesting honey, if a beekeeper reached brood combs, he removed one or two of them to add to a weak colony. Fert (1985) again found log hives, and also colonies kept in covered hollows in sloping ground. A cooking pot might also be used as a hive, or two placed mouth to mouth – sometimes with a hollow log between. In the Central Highlands where trees were lacking, hives were built of mud bricks, like miniature houses (Chandler, 1975a), but this may have been a recent innovation.

From Madagascar, *A. m. unicolor* was taken to other islands in the Indian Ocean which were without honey bees: Réunion in 1666 and Mauritius in 1721 (Table 36.4B). The traditional hives I found in both these islands in 1982 were made of wood, used horizontally, and called *bombard*; most were cylindrical. They were placed on or near the ground and protected with a layer of large leaves.

Beekeeping probably began somewhat later in the Seychelles (Ratia, 1984). Bernardin de St Pierre wrote in a letter in 1768 that bees were present, whose honey was '*assez bon*' and naturally liquid. According to Dufresne's expedition journal to the Seychelles in the same year, he saw bees but no hives. The first bees in the islands were probably *A. m. unicolor*, followed by European bees from France, and then Italians. In recent decades hives were long boxes made from scrap wood, and no references have been found to different hives in earlier years. Many colonies nested in the wild and were the source of bees put in hives. Top-bars were used in some hives 'for many decades', longer than in mainland Africa (Paterson, 1989), but it is not clear when or by whom their use was initiated. Silberrad (1970) and Ratia (1984) described beekeeping in general.

Islands off the Atlantic coast of Africa are discussed in Section 25.33.

28.8 What can be deduced about the history of the beekeeping?

There are no pictorial or archaeological clues to past hive beekeeping in Africa south of the Sahara. In addition, few of its many languages were written, and beekeeping was first described in writing by literate travellers in the 1800s. We thus know almost nothing about the development of hive beekeeping through the centuries. What we do know is that almost all traditional hives in Africa south of the Sahara are used horizontally, and their shapes are similar in many ways to those known from the Ancient civilizations of Egypt, Greece and Rome. It seems to me likely that knowledge of hive beekeeping was disseminated from Egypt south along the Nile valley, which stretches along half the length of Africa. (T. Shaw (1992) thought the possibility should be considered that hives in Ancient Egypt followed the style of horizontal log hives used farther south.)

In any locality, beekeeping and other traditions would have been handed down unchanged from father to son, and probably varied only when one people came into contact with another, through close proximity, migration, trade or conquest. The present distribution of different spoken languages throws some light on the past movements of peoples in Africa south of the Sahara. Following Greenberg (1963) and Phillipson (1985), the language families are roughly as follows.

	Relevant Section
Afro-Asian (Hamitic-Semitic) and Nilo-Saharan	28.2
The same, with Bantu in the south	28.3
Niger-Congo and Bantu	28.4, 28.5
Khoisan (Hottentot and Bushman)	28.6

Traditions of hive beekeeping in Egypt that reached Afro-Asian peoples farther south could also have been spread westward across the Sahel in the widest part of Africa as a result of the movement (or local marriage) of men travelling along Arab trade routes which are known to have existed from the 900s (Lewicki & Johnson, 1974). The traditions could also have travelled further south of what is now Sudan, to peoples living in highland regions bordering the Rift Valley (now in Ethiopia, Kenya and Tanzania). These regions are much richer than the Sahel in both bee forage and hive materials.

Populations of Bantu-speaking Negro farmers, similar to those in West Africa, expanded into and across southern Africa in Stone Age and Iron Age times (Barraclough, 1978). Most of the peoples living in settled agricultural societies in the 1900s were already doing so by about AD 1000, so hive beekeeping could have been practised in many areas by that time, and it may have been fairly similar to what we see today. In the south, hunter-gatherer Khoisan-speakers were driven by Bantu-speakers into the small areas they now occupy in the Kalahari region of the south-west, where they got all their honey from natural nests until the late 1900s.

There were fewer large centres of population in the African tropics than in the region to the north, but between AD 900 and 1500 a succession of states and kingdoms grew up, and declined again, in an inland belt south of the present Sahel which may then have been less dry. Did beekeeping advance, and become important, among any of these populations, as in some others in the Ancient World? Between the 800s and 1400s, beeswax was used in West African coastal regions for making superb bronze castings by the lost-wax process (Section 49.45). Was this wax obtained from hives, and did the demand for it have any influence on the development of hive beekeeping? I do not know the answer to either of these questions.

29

Traditional Hive Beekeeping in Asia East of Persia

29.1 Asia compared with Europe and Africa

The tropics of Asia are similar to those of Africa in that temperatures are high enough throughout the year for honey bees to fly and for plants to flower. In both regions the periods of flowering are usually determined by dry and wet seasons, and colonies of the tropical honey bees developed a strategy for surviving dearth periods which is impossible in cool temperate zones: when flowering finishes in one area, the adult bees of colonies can abscond, flying *en masse* to a nearby area where other plants are coming into flower (Section 4.5).

In Europe and Africa the native hive bee is *A. mellifera*, whereas in Asia east of Persia it is *A. cerana*, a smaller bee than *A. mellifera* which does not forage so far afield; it lives in smaller colonies which store less honey (in smaller combs that weigh less when full). Further, in much of lowland tropical Asia – from the Persian Gulf to the Philippines and the chain of islands in Indonesia – people could also get honey and wax from colonies of other species of honey bee which nest in the open: *A. dorsata* or *A. florea*. And an *A. dorsata* colony can produce much more honey than a colony of *A. cerana*.

Hive beekeeping with *A. cerana* seems to have had at least two beginnings: one in China in the east of the bee's range (Section 29.2), and the other in the upper Indus basin in the west (29.5). From 2500 to 1750 BC there was an important civilization in the lower Indus valley, but *A. cerana* is unlikely to have lived in this hot dry region, although *A. florea* was probably present and perhaps also *A. dorsata*. Table 29.7A lists the earliest dates found for hive beekeeping with *A. cerana* in individual countries. All are much later than in Egypt, and many countries lack records. No early dates were found for lowland tropical countries where there were many nests of the more productive *A. dorsata* (Crane, 1989a). Hive beekeeping with stingless bees occurred sporadically in tropical Asia (Section 30.6).

Traditional hive beekeeping in Siberia is discussed in Section 36.41, with the introduction of *A. mellifera*. No record was found of traditional beekeeping in Mongolia, and no archaeological finds in Asia east of Persia have so far been identified as hives.

29.2 China

Dr Joseph Needham (1958, 1984) found very little information on the history of Chinese beekeeping. Appendix 1 contains scattered references to honey, bees, beeswax and beekeeping up to AD 1600, in chronological order, and many of the entries include more information than is given in the text below.*

Honey was mentioned from about 2000 BC onwards, and bees before 1000 BC. Beekeeping was referred to in the East-Han dynasty (AD 25-150) as one way 'to acquire wealth'. Between AD 158 and 167 it was stated that more than 300 men went to Hanyang to learn beekeeping, and in AD 232 an essay on beekeeping mentioned a wooden box hive. In the Ts'in dynasty (265-420) a government proclamation offered a reward to beekeepers who kept productive colonies. Also, a manuscript *Natural science book* written by Chang Hwa between 265 and 290 contained the following passage. I first understood it in 1989 when I was with some groups who kept bees in the forested mountains of north Vietnam near the present border with China, who followed a very similar procedure (Section 29.41).

> The quiet distant mountains produce beeswax; people collect bees with a barrel: they take honey and wax once a year. These beeswax-producing places are beyond the distant mountains. People use wooden vessels and bore holes in them, and rub beeswax on the inside and outside of the vessel. They catch several bees into the vessel in spring time, and a moment later let the bees fly away, then these bees will

*I have not been able to evaluate these entries effectively, and I hope that someone with the necessary knowledge and facilities will be able to do this.

Figure 29.2a Drawings of representative traditional Chinese hives, reproduced in many beekeeping books. *left* Horizontal log hives, on two types of low stand. *right* Hives under house eaves: *above*, upright barrels on shelves; *below*, suspended horizontal box hive.

> accompany a lot of other bees to the vessel, and after two or three days the vessel contains many bees, and the people take it home. (Translation by Kenneth Tsang, 1979)

By the 500s district reports, and books on natural science and medicine, referred to beekeeping, and in the 700s bees were used in the diagnosis of human diabetic glycosuria (Appendix 1). Between 1000 and 1100 writers were able to describe a worker, king (queen) and queen cell, and to give some idea of colony life and the beekeeper's management of hives. During the Yüan dynasty (1260-1368) beekeeping work through the seasons was described, and colonies could be united and divided. In 1273 the Board of Agriculture printed a textbook that included beekeeping, which was 'immediately distributed all over the country' but unfortunately no copy survives. This book preceded by some two centuries the first books printed in Europe.

Recent traditional hives in China were wooden logs, boxes and barrels, and these are still found in more remote areas (Figure 29.2a). Upright hives were probably used more in the north, and horizontal ones in the south. Hives of woven plant stems such as that in Figure 29.2b were less common than those of wood.

From 1911 to 1936 Kellogg lived in the south-eastern Fukien province opposite Taiwan, where only traditional hives were used until about 1920, and (1968) he said that the beekeeping was similar to that described in AD 232. Wooden box hives were about 45 x 25 cm and 30 cm high internally, but the size varied. They were hung on a house wall under the eaves as in Figure 29.2a, and were usually unpainted. The entrances (10-12 holes) might be in the outer long side or at one end. In Hinghwa 130 km south of Foochow, the sides were of white plaster on which poems were painted, and the wooden parts were deep blue. In north Fukien, wooden barrel hives were placed on their side directly on earth. Bees built combs in any direction in the hives, and often attached them to the side walls as well as to the top. Either end of a hive could be removed to examine or harvest combs; sometimes the bottom was hinged and could also be opened for cleaning, or to look for

Figure 29.2b Horizontal woven hive with wooden insert containing five entrance holes, Hong Kong, 1968 (IBRA Collection B68/14).

queen cells. A little smoke from a joss stick or taper might be used, but more smoke made Chinese bees 'wild'. Beekeepers did not practise any swarm control, but they pinched off surplus queen cells in a colony which had just swarmed. They captured a swarm in a tall basket, if necessary mounted on a long bamboo pole. Disturbance could make a colony abscond, but colonies in Fukien did not abscond seasonally. Beekeepers migrated their hives to nearby mountains, although there were no roads; a man carried a bamboo pole over each shoulder with a hive slung from each end of it.

The first mention of hive beekeeping in the island of Taiwan seems to be a record (from around 1700) that farmers in Kuan-tze-lien near Chai-i collected colonies of *A. cerana* from trees and caves, and kept them in 'primitive' hives in their house yards (Hon, 1962; Yen & Ho, 1977). According to Kiang (1979) 'about 40 years ago, native bees were kept in bamboo baskets ... one or two hanging under the eaves of farm houses'.

The hive bee in most of China, and in Taiwan, is *A. cerana cerana*.

29.3 Korea and Japan

The honey bee here is *A. cerana japonica*.

29.31 Korea and neighbouring areas

Choi (1984) stated that *A. cerana* was first introduced to Korea at the time of the Koguryo Kingdom, in about the 30s BC, but since Korea adjoins China it is likely that the bees were present long before this. Records from about AD 300 refer to the collection of wood honey from nests in old trees, and stone honey from those in rocks (Section 10.31).

The earliest direct reference found to hive beekeeping in connection with Korea (see Section 29.32) was written by Nihonshoki in AD 720 and referred to AD 643: 'In this year, Prince Yohō of Kudara, Korea, tried to keep honey bees in four combs at Miwayama [the holy Mount Miwa in Japan], but this trial did not succeed.' In the AD 300s Buddhism had reached Korea, and Lee (1981) said that Buddhist monks 'started to raise their own bees' in 940 and used the honey harvested – known as temple honey – on special occasions.

Korea lies in the northern deciduous forest belt, and recent traditional beekeepers used upright log hives (Figure 29.3a) rather similar to those in northern Europe for *A. mellifera*. According to Takata, who wrote about Kei-rin San in Chunan province in 1937,

Figure 29.3a Upright log hive in Korea (Sangyō-Yōhō, 1934).

a pine log about 75 cm high and 30 cm in diameter was cut from a tree, and its interior carved out to leave a wall 25 mm thick. The flight entrance was a 30-mm hole near the bottom on the south side. The hive stood on a flat stone and was covered with an inverted porcelain dish, any gaps being filled with mud; in summer a straw cover was added. After 3-5 years the bees were killed during the winter season, and the honey squeezed from the combs.

On the Pacific coast north of Korea, *A. cerana* lived in the forests of Ussuriyisk in the Primor'ye province of Russia. When peasants were moved there from European Russia in the 1880s, they tried to keep *A. cerana* in log hives such as they used for *A. mellifera*, but had difficulties and lost many colonies through swarming (Bussey, 1896; Crane 1978c).

The (Japanese) Tsushima islands between Korea and Japan were a stronghold of traditional beekeeping, and still had 4000 hives in 1990. The hive, similar to that in Korea, was an upright log; those measured were 51-54 cm high and 36-39 cm across. Otsubo (1990) described the beekeeping conditions, and Taro Inoue (1981), Sugimoto (1989) and Takuno (1991) the hives and methods of using them; Yoshida (1990) explained how honey was harvested.

29.32 Japan

What may well be the first reference to honey bees dates from May 625 when, according to Nihonshoki in 720, 'a large crowd of flies as large as 5 m rose up in the sky and flew over Shinanosaka with a terrible roar like thunder ...', and this could have been a swarm in flight (Ko Watanabe, 1965, 1981).

It is not clear when hive beekeeping started in Japan. The earliest attempt is often quoted as that in AD 643 (Section 29.31). However, Watanabe (1984) pointed out that Yohō could not have taken honey bees from Korea to Japan in that year, because he had been a hostage in Japan since 631. Moreover Yohō's attempt at keeping bees on Mount Miwa was likely to have been a religious exercise carried out to ensure his success in counter-attacking North Korea and China, and so in restoring his ruined fatherland in south Korea. (Honey bees were commonly used for prognostication in Ancient Japan, and Mount Miwa in Nara prefecture was then an extremely sacred place. Yohō returned to Korea with Japanese troops in 663 but was defeated, and Nihonshoki's reference in 720 could have cited Yohō's failure with beekeeping as a bad omen which predicted this defeat.)

About 1160, at the end of the Heian era, the Prime Minister Munesuke Fijiwara was reported to keep bees; see British Bee Journal (1986). But few details of Japanese beekeeping are known until it was described and illustrated in books in the late 1700s. The 1791 manuscript of Atsuyuki Kuze's *Kahō-chikuyōki* (Keeping domestic bees), in the Library of the National Diet, Tokyo, described: the queen and queen cell; how to make a hive; reasonable height of a hive; location of the apiary; struggles among bees; swarming; drones; wax moths; how to extract honey; how to render wax. In 1799, Kenko Kimura's *Nihonsankai-meisanzue* – which referred to Mount Miwa mentioned above – was illustrated by Kangetsu Shitomi, and a drawing in the section on Kumano district is similar to Figure 29.3b here.

Risshi senchufu (Illustrations of a thousand insects) by Zuiken Kurimoto (1811) dealt with the honey bee and the silkworm. One painting shows a horizontal cylindrical hive made by binding plant stems together, and in another the hive is opened and the combs can be seen. In the 1840s Nariaki Tokugawa, a *daimyo* (feudal lord) of Mito-han, wrote *Keizan yohoruku* (Keizan's beekeeping notebook) using the pseudonym Keizan. This described practical beekeeping which he considered a good industry for his subjects. The book and some letters, now in the Shoko-kan Museum in Mito, were discussed by Hara (1993). Nagatsune Ohkura wrote *Koekikokusanko* (On domestic products as public benefits) in 1859, and it included the drawing reproduced in Figure 29.3b.

In 1872 *Hachimitsu-ichiran* (Outline of honey) described traditional beekeeping with horizontal logs and tiered boxes, swarm collection, and honey harvesting from one end of a box hive: 'Pat the back door of the hive, and bees will move towards the front, so that you will be able to cut out two-thirds of the combs.' The book was published for an exposition in Vienna in 1873, and has the most detailed illustrations of any mentioned here. Ko Watanabe (1986) gave full details of the book and published an 8-page leaflet on it; Figure 40.3d shows hives of tiered wooden boxes.

Figure 29.3b shows traditional beekeeping in the 1800s, including horizontal cylinders and boxes of various shapes that were used as hives. Bees were brushed off the combs when honey was harvested, and a feather was used to move bees from a swarm cluster into a collecting box. Honey was separated from the wax of the comb in a screw press, and prob-

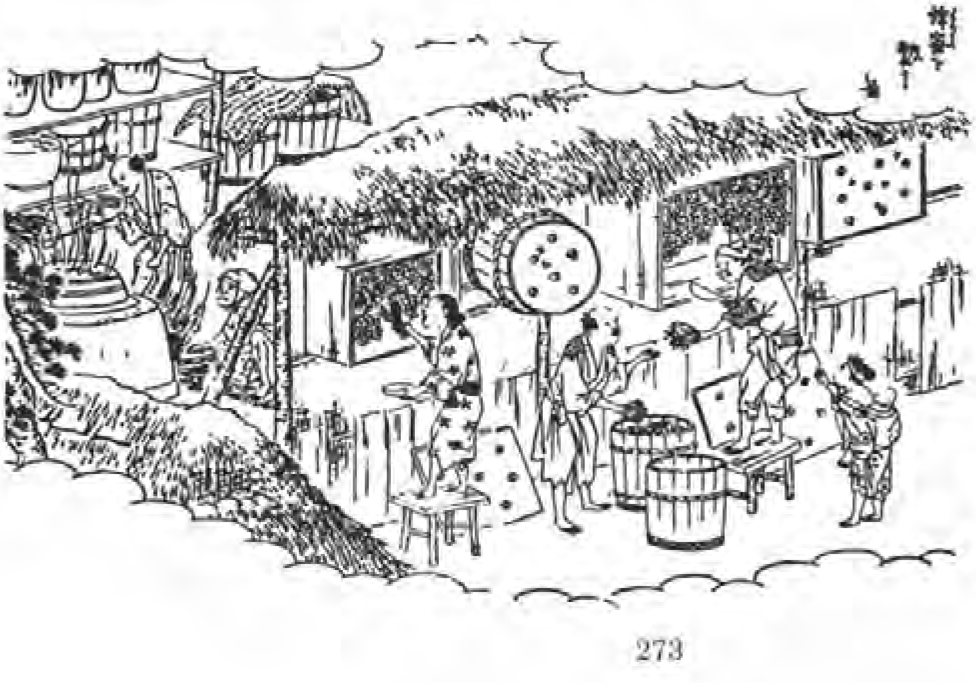


Figure 29.3b Woman harvesting honey from one hive, and two men doing so from another, watched by another woman carrying a baby (*Koekikokusanko*, Japan, 1859).

ably also by heating them together in the open. No illustrations show the use of protective clothing, or of smoke to subdue the bees.

In 1984 in Kyushu in the south, I saw upright box hives from which honey was harvested by slicing across combs between the flat cover and the hive walls and then cutting honey combs away; combs left had sufficient attachments to the side walls to secure them. Sawada (1986) described two types of traditional beekeeping on the Kumano peninsula in southern Honshu. In one, box hives were kept near the house (as on Kyushu) and populated by catching swarms from existing colonies; most colonies there survived the winter. In the other, empty log hives were set out in the forests in April/May to be occupied by swarms; all the combs were removed when honey was harvested and no colonies were overwintered.

Discussions I had with Drs Mitsuo Ichikawa, Tamiji Inoue and Matsuto Sawada at Kyoto University in 1984 concluded that traditional beekeeping methods were introduced into Japan from both Korea and China. This could account for the Japanese use of both horizontal and upright log hives, and of barrels as well as boxes made of wooden boards.

In the past, traditional beekeeping was carried out on all the main Japanese islands except Hokkaido in the north where it is too cold. Movable-frame hives of European *A. mellifera* were in common use from 1920 onwards, and traditional beekeeping with *A. cerana* became increasingly restricted to uncultivated land with native flora – where this bee did well but *A. mellifera* did not find enough forage to survive. The areas included: parts of Kyushu; several parts of the small island of Shikoku (see Figure 29.3c); and around Kumano on the Kii peninsula in the south of the main island, Honshu. In Ehime on Shikoku, Ochi (1985) found 694 box hives of *A. cerana*; in the hills they were suspended under the eaves of houses, and in the plains they were placed on stands. Ehime then had 13,500 modern hives of *A. mellifera*. Among Ochi's 16 photographs is one of an upright log hive.

In the Ina valley north-west of Tokyo, a beekeeper with a variety of hives used them for different purposes, e.g. upright hives for collecting swarms and horizontal hives for honey production (Iwasaki & Ihara, 1994).

Figure 29.3c Traditional box hive packed for winter and secured to a house wall, Shikoku, Japan, 1957 (photo: I. Okada).

29.4 South-East Asia

In this region traditional hive beekeeping with *A. cerana* differed from one country to another. There was a long and rich tradition in northern Vietnam, as in China, but virtually none in the Philippines east of Vietnam, or in Laos and Cambodia west of it (Section 29.42). Only traces were found in Thailand (where it was probably introduced in both the far north and the south) and in Myanmar farther west (Section 29.43). In Indonesian islands and peninsular Malaysia, use of a horizontal log split lengthways, referred to as *glodok*, was scanty but widespread (Section 29.44).

29.41 Vietnam

Dong Son, in the Red River delta region near present Hanoi in northern Vietnam, was famous around 500 BC for its large bronze drums which were made by lost-wax casting. The beeswax could have been obtained from *A. dorsata* or *A. cerana*. A Việt state was founded in 196 BC, and for long periods from about 111 BC, during and after the Chinese Han dynasty, the north of it was under the jurisdiction of the southern Chinese Empire. In China during the Ts'in dynasty, Chang Hwa (AD 265-290) described a method for getting a swarm to settle in a bait hive (Section 29.2); in 1989 Nung beekeepers in Bac Thai, in the forested mountains of north Vietnam, demon-

Figure 29.4a Beekeeper setting off for the forest with his net and bait hive, Bac Thai, north Vietnam, 1989 (photo: E. Crane).

strated to me how they carried out a very similar operation. They kept bees in upright logs and used somewhat smaller logs as bait hives (Figure 29.4a). In spring, when scout bees started flying in the forest in search of a nest site for their swarm, beekeepers took bait hives – rubbed inside with honey/wax – and placed them in the forest, often near the base of a large tree. A beekeeper caught a few of the scout bees (nowadays in an insect net), and confined one in the hive for 20-30 minutes, then released it to fly back to its swarm. An hour later, some hundreds of bees were likely to come and inspect the hive, and the whole swarm would arrive the same afternoon. The bees were then taken home in the bait hive. In Lao Cai, near the Chinese border 200 km west of the Nung, scout bees searched for nest sites in mountain valleys where Mung people kept hives round their houses. In 1992 I found that these people followed a similar practice to the Nung, except that they caught the scout bees flying near the house, and needed no separate bait hives.

Information about beekeeping survives from the 700s, during the Chinese T'ang dynasty when Pham Lé, Great Minister for the land of the Viêt, wrote an account of it (Faraut, 1909b). Bees were understood to some extent. According to the annals of Nam-Tâm, they had a *chua* or king (queen), to whom the *quân* or soldiers (workers) and the *con tuong* or chiefs (drones) showed entire fidelity. The great scholars of Antiquity affirmed that this was true. Drones were said to be produced in March/April and to be charged with fermenting the honey collected by the workers, but in September/October 'they disappear, their further existence being harmful to the colony; there is no more honey to be harvested until next summer'. People in the forests collected bees from tree or rock cavities to populate their hives. These were baskets or boxes made weather-tight with clay; 'One side and the lids of the hive are arranged so that they can be removed easily, to harvest the honey or to inspect the bees'. Honey was extracted by pressing combs, and wax by heating. Honey was stored in porcelain jars. Another statement, that pollen from orchids was collected by the bees as special food for the queen, is referred to below.

In Le Quy Don's 1773 encyclopaedia *Van dai loai ngu*, paragraph 286 is on bees – from the context *A. cerana* – which Ngugen Trinh Liet translated for me. It states that the queen lays the eggs, and when these develop into young adult workers the colony divides, and each part has its own queen, just like the head of a feudal state; the workers never take over, however populous the colony becomes. (Present beekeepers in the mountainous region of Vietnam customarily reduce the numbers of queens, in order to get many workers and much honey.) Another sentence reads: 'Bees carry normal pollen to the hive on their legs, but delicate pollens, reserved for the queen, cover their heads.' This statement, together with the mention of orchid pollen during the 700s (above), strongly suggests that pollinia were observed; these are sticky masses of pollen produced by some orchids, which become attached to the head of an insect collecting nectar from the flower.

Fougères (1902) and Dufour (1902/03) both described an upright log hive as hollowed out from the top, the bottom being left closed. The flight entrance, somewhere in between, was marked with a circle of white chalk. The hive was covered with a small board or boards secured with clay or buffalo dung, and it was placed at the gable end of the house a metre or less from the ground, on a wooden log. It was taken inside the house to harvest the combs; the bees on one comb were smoked and that comb removed, then those on the next, and so on. Inside the hive, sticks were fixed at right angles to the walls, at different levels, to support the combs. Reading the two 1902 accounts, it is clear that these sticks, also called *bâtonnets*, were cross-sticks such as those used in a skep, and not top-bars. The hive was populated with a swarm, the queen being fastened to the central stick.* When Faraut (1909a) bought two small hived

*A newly hived *A. cerana* swarm is likely to leave unless the queen is prevented from doing so, by temporarily caging, tethering or tying, or by cutting her wings – which must not be done unless she has already mated.

swarms, the queen of one of them was in a cage made from a ring of small sticks whose ends were inserted into two round pieces of banana-trunk tissue.

Toumanoff (1933) and Toumanoff and Nanta (1933) described beekeeping in Tonkin (north Vietnam), in both horizontal and upright log hives.

Mulder (1991), who spent several years working with beekeepers in Vietnam, reported on traditional colony management he saw in the north. Both honey and brood combs were harvested. Some beekeepers did this once in the season and killed the colony; others left some combs in the hope of getting a further harvest later on, and still others used a more skilful procedure which ensured future harvests. They cut a comb out of a horizontal box hive from an opened side, and separated the brood comb below from the honey comb above. They used a forked bamboo stick to fix the brood comb against the original attachment area of the comb on the roof of the hive (Figure 29.4b).

Certain beekeepers specialized in collecting wild colonies from nearby forests. The brood comb, honey comb and bees from a nest might be taken home in separate containers; so that the queen did not escape, she was tethered by a hair bound round the wings, or round the petiole between thorax and abdomen, as reported by Poilane (1926). Back in the village, the colonies were put into hives and sold to other beekeepers. Alternatively, beekeepers set up bait hives during the swarming season, and those who did not live near the forest spent several days there, enticing swarms to occupy their bait hives, as described above.

Figure 29.4b Forked bamboo sticks used to support brood combs placed in a fixed-comb hive, Cat Ba, north Vietnam, 1990 (photo: V. Mulder). The bees have already re-attached their combs.

Toumanoff and Nanta (1933) also reported the use of hives 'divided into several stories, communicating by a small hole' in Tam Duong, Vinh Yên province; similar hives were used in Korea and Japan, and perhaps also in China.

Section 39.52 describes beekeeping with top-bar hives in north Vietnam.

29.42 Laos, Cambodia and the Philippines

Peoples of these countries do not seem to have kept bees in hives, except perhaps the Lisu who did so in Thailand (below). According to the Embassy in London in 1956, hive beekeeping was not practised in Cambodia, but up to 140 tonnes of honey were collected annually between 1950 and 1955, most being exported, and up to 3.7 tonnes of wax. Much of this may have come from *A. dorsata* nests. In Sekong province, Laos, colonies were tended in purpose-made tree cavities (Section 16.3).

In the Philippine islands there are references to harvesting combs from natural nests of *A. dorsata* and *A. cerana*, but I have found none to traditional hive beekeeping. Karlsson and Svensson (1991) agreed that it may never have existed, but one community in Mindoro said they had tried unsuccessfully to keep both *A. cerana* and stingless bees in logs. *A. mellifera*, and movable-frame hives, were introduced in 1913.

29.43 Thailand, Myanmar and Assam

Thailand

Traditional hive beekeeping with *A. cerana* can be found nowadays in several parts of Thailand, but it is not widespread and is not considered old; Wongsiri (1988, 1989) believed that it started in the early 1900s, and I know of no records before then. In recent decades some hives were made from wooden boards or bark of the coconut palm, but most were hollow logs; in 1986 I saw upright hives round Chiangmai in the north, and horizontal hives in the south. Henry (1980) summarized methods used by the Lisu, people of Sinotibetan origin who lived at altitudes between 1000 and 2000 m in the rather wet mountain country of northern Thailand, Laos, China and Burma. They kept horizontal log hives – usually 2 or 3 – on shelves against the house wall, rather low down but sheltered by the eaves.

In peninsular Thailand to the south, for instance

Figure 29.4c Part of a home apiary of traditional horizontal hives each shaded by a large leaf, Ko Samui, Thailand, 1986 (photo: E. Crane).

in Surat Thani and Prachuab-khirikhan where horizontal logs were used, colonies were brought home from the forest in cloth bags. When they were hived, the queen was confined in a wire cage until combs were built, and her wings might be clipped before she was released. Akratanakul (1976) said that beekeepers harvesting honey smoked the bees heavily so that they would all leave the hive, and that some beekeepers left honey and brood comb in the hives 'to attract the absconded bees'.

Ko Samui, an island 11 km wide off the east coast at 9°N, is unusual in that traditional beekeeping was done on quite a large scale in the 1900s. In 1986 I visited 5 of the 120 beekeepers on the coastal plain, and Figure 29.4c shows one apiary. A beekeeper took between 1 and 5 honey harvests a year, from about 20 to 1500 horizontal hives: logs, boxes or concrete pipes.

When the rainy dearth season started on the plains, most colonies absconded and built new nests in the jungle-covered hills in the centre of the island. When the next flowering (dry) season began on the coastal plains the colonies returned there, and beekeepers put out empty hives to attract the swarms. One of the beekeepers, Samart Pauchaweng, knew that a colony with a young queen rarely absconded, so during the two major colony reproductive seasons he divided his colonies and let one part rear a new queen. As a young man he had noticed that the bees 'all go where the queen is', so he cut out honey combs from a hive until he reached the brood comb where the queen was, then caught her and tethered her by a thread round the petiole, and put her in an opened empty hive placed very close by. When a number of the bees had joined her, the hive was moved away. Enough bees returned to the original hive to rear a new queen, provided this contained eggs or young brood.

Hives on Ko Samui show similarities with some in China (Figure 29.2a, left), and it has been suggested that beekeeping there was initiated by Chinese, either traders (Wongsiri, 1988, 1989), or people who escaped from China at the end of the Ch'ing dynasty in 1912 (Nakamura *et al.*, 1991).

Myanmar

Beekeeping with *A. cerana* does not have a long history in Myanmar. Traditional hives have no standard shape, size or orientation, and they are opened either from the front or the side. In recent years (Maung Maung Nyein, 1984) the most common hive, used in Kachin, Karen and Kayah states, was a hollow horizontal log between 20 and 60 cm long. Each end was closed with a wooden board, and the flight entrance was 'in front'. I have also heard of hives made from cooking pots, with a flight entrance bored in the side, kept on a wooden stand. They might be inverted, and honey combs harvested from the mouth, or upright with a convex lid over the mouth which served as a honey store. Wooden boxes of any size and shape coated with cow dung were used all over Burma, mostly as bait hives.

Individual hill peoples had their own hive styles.

Those from Dawna Range in Karen state used a bamboo internode, with small holes drilled in it for flight entrances. They hung the hive 'vertically' from the ceiling outside their hut. Peoples from the Chin Hills used a water pot with its body buried in the ground 'to protect the bees from cold'. Underground hives were made by digging a hole in a southern slope and baiting it with a piece of honey comb. A wooden board provided the bees with a roof, and a flight entrance was contrived with small stones.

Colonies might be obtained by collecting them from natural nests in the forest; or bait hives, coated on the inside with beeswax, were put out when swarms were due to fly into the area, in January/March and August/October. To harvest honey, beekeepers smoked the colony heavily – unusual with *A. cerana* but also reported from Thailand – so that the all bees left the hive. 'The wise beekeeper' left some honey to attract a swarm; what he harvested, he squeezed from the combs with his hands. The main obstacle to beekeeping was colony absconding, and some beekeepers clipped the queen's wings. One in Kachin state in north Myanmar tethered the queen by a thread round the petiole.

Assam

Assam occupies the Brahmaputra basin and surrounding mountains, and has been a state of India since 1947. There are several points of similarity between traditional hive beekeeping in Assam and in present Myanmar, and some of the peoples in the two regions are related. (In 1954 Muttoo was told that where beekeeping was practised in Assam it was similar to that in Himalayan regions farther west, but I doubt this.)

The 1883 reports on India referred to in Section 29.6 give the following information. In some parts such as Cachar only honey hunting existed (Report 955R by J.K. Wight). Beekeepers in certain other areas carried out several of the more advanced operations known in parts of eastern Asia. They constructed bait hives underneath stones for incoming swarms. They used a log hive with 'a small door put on each end, one for the bees to come and go, and the other to take out honey' (Report 1192). They removed from a hive old unoccupied comb that the bees would be unable to protect from wax moths, and thus got new comb built. When they wanted bees for hives, they located nests in the jungle by tracking bee faeces.

They were also very deft in finding and handling queens. They caught the queen of a colony 'by simply searching for it with their fingers'. When putting a swarm in a hive they tethered the queen 'by a piece of string tied to her wings'. In the Khási and Jaintia Hills, 'the queen-bee is tied up by a thread or hair for some time to a stick in the hive in order that it may not fly off'; also 'a piece of string is tied to the [queen's] wings'. Or the wings were removed to prevent her leaving. When a queen died it was 'customary to take a queen from another and a weaker swarm [colony] and introduce it instead of the dead one, and if sufficient time (about 18 or 24 hours) be allowed to pass before the introduction of the new queen, the plan is always successful'.

29.44 Indonesia and Malaysia

Indonesia

Indonesia occupies almost all the chain of islands – previously the Dutch East Indies – that stretch from the Molucca Straits in the west to New Guinea in the east, more than 5000 km. Individual islands are very diverse and have had different histories. *A. cerana* is in the islands as far east as Sulawesi and smaller islands beyond, and in 1985/86 hives of these bees were taken to Irian Jaya in New Guinea.

Vries (1994) collected much information from Dutch records made in colonial times. The earliest found was by Low (1848) about Sarawak in north Borneo: 'A smaller bee [than *A. dorsata*], called *nu-ang* by the Dayaks, is sometimes domesticated in hives of bamboo or bark, [placed] about their houses.' Hoekman (1929) quoted Hirst's 1861 account as the first; Hirst was Assistant Resident in Sambas in West Borneo, now in Kalimantan. The Dayak people put hives* smeared with honey in the forest to attract swarms, and took the occupied hives back to a site near their house. Honey was harvested three or four times a year.

Hoogeveen (1864) described how *A. cerana* colonies were kept in hives in Bandung, in the mountainous Pangrango region in west Java. The hive was a *glodok* 45-60 cm long and 15-30 cm across. It was populated by hanging it in the forest until a swarm took possession, then carrying it home. At harvest time, the two halves were separated to get at the combs. Veth (1876), who also found *A. cerana* in such hives in Java, said that one could yield 12 combs of honey a year, and that the beeswax produced was sold in small blocks at local markets. Provided a hive was not disturbed, and not too much

*The Dayak word was written *glodok*; *glattok* or *gelodog* was used in Indonesia and Malaysia for a horizontal hive made from a log cut into two parts lengthways and reassembled (Figure 29.4d). The ends were closed with wooden boards, and a flight entrance made (or left) at one end.

honey taken from it, the bees remained in it for many years.

Franssen (1931) described several other hives in Java. One, used in and around Bantam and the Gedangan region, was a hollowed horizontal log, 50-100 cm long and 10-25 cm across, whose ends were closed by wooden boards or half coconut shells; bees entered by any spaces around them. Around Blitar, Yogye and Blora, hives were similar to those seen in 1864 and 1876 (above). In Pangrango, especially round Bandung, Franssen found primitive boxes with a removable wooden lid. All hives were hung under the eaves of houses, or a *glodok* was sometimes supported from the ground by two pairs of bamboo canes.

In the south Yogye area, and Purworejo south-west of Magelang in central Java, Franssen found primitive hives made by hanging up an inverted earthenware cooking pot, its mouth covered by a wooden board which contained one or more flight entrances. Around 1870 some 5800 people in Purworejo kept bees as a sideline, using a *glodok* or a clay pot (Beetsma, 1977a), and swarms were obtained by setting out baited hives. In existing hives, young queens were killed to prevent swarming. Honey was harvested every 6 weeks in the monsoon season, by cutting out half the combs, and brood was removed and eaten. Gelpke (1896) reported that beekeepers in Purworejo found and tethered the queen, and Vries (1990) also observed this practice. Roepke (1930) described a larger hive made from strips of bamboo and shaped like a kettle drum; it was hung up above the front door.

Figure 29.4d *Gelodog* containing a very small colony, with the top lifted off, Johore State, Malaysia, 1988 (photo: E. Crane).

Malaysia

It seems likely that hive beekeeping is very recent in Malaysia, and was introduced from Java. The hive is a *gelodog* rather similar to that described in the previous footnote.

In 1924 Mathieue discussed the possibility of keeping *A. cerana* in hives, and in 1936 the *Magazine* of the Malayan Agri-Horticultural Association reported that Malays 'keep their bees in hollow logs, split lengthwise and tied together with rattan or wire, by which they are hung from low branches or the joists of the house floor'; many houses were on stilts. Hives were not supported from the ground because of damage by ants. Swarms usually settled on inaccessible branches of high trees and were not taken, but an empty hive hung in a suitable place was nearly always occupied by a swarm. Harvesting was done at night; all combs were removed, and although the bees were not killed they often died, but the hive would soon be occupied by another swarm. The 1936 author also made and used movable-frame hives, and Phoon (1983) referred to these as the first recorded evidence of beekeeping in Malaysia; Figure 41.6a shows a recent hive and its frames. An account by Allen in 1953 suggests that beekeeping presented some problems, and according to Otis (1989) 'there would have been at most a few hundred' *A. cerana* beekeepers in 1979. I saw a small number of the *gelodog* in 1988, a few in Selangor and more in Johore to the south. A (heavy) log from a coconut palm was cut lengthways twice, and used horizontally. When the top was lifted off the combs came with it as in Figure 29.4d, and this made harvesting easy. The separate floor enabled refuse on it to be cleared away.

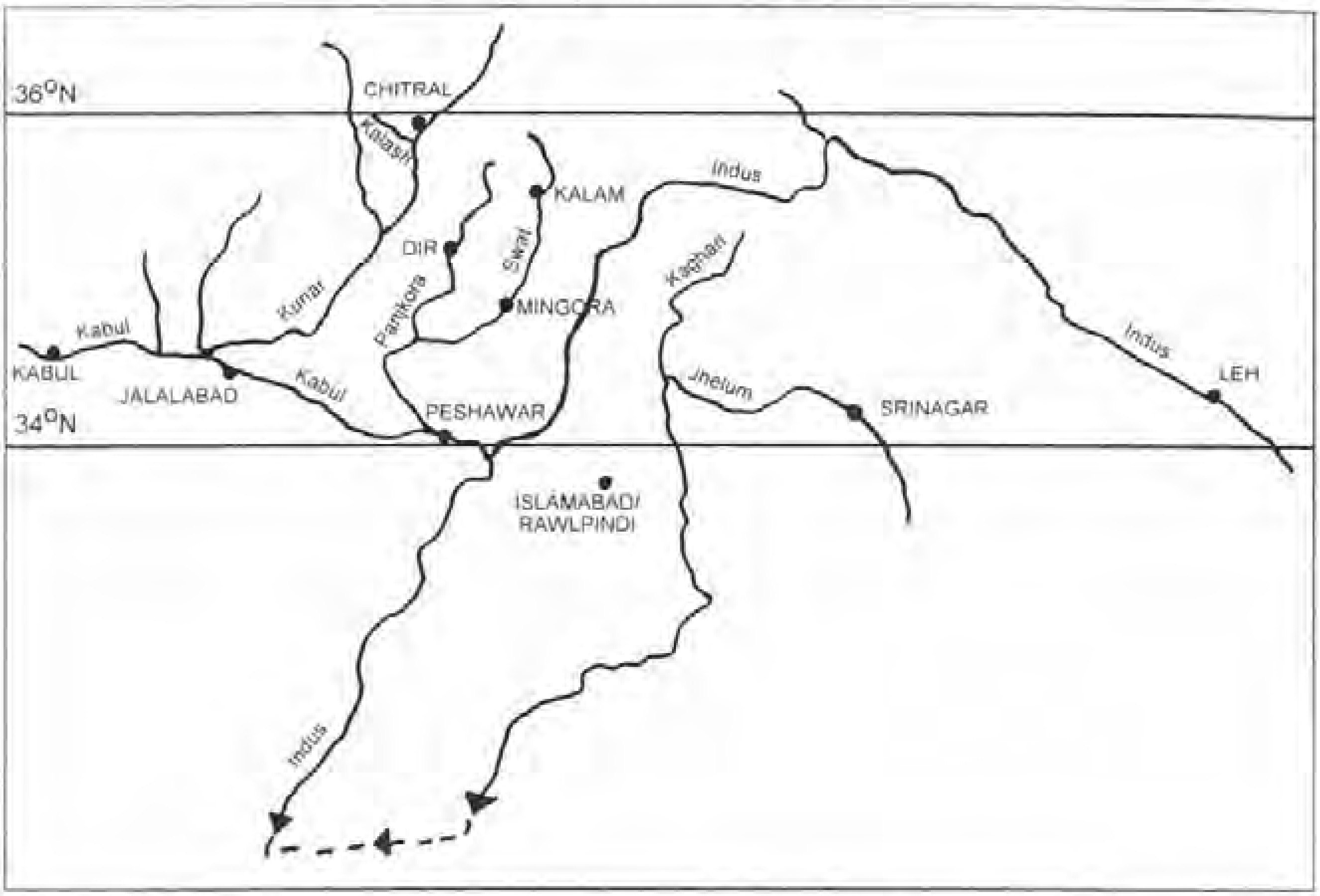


Figure 29.5a Map showing valleys of the upper Indus basin mentioned in the text.

29.5 Upper Indus basin and adjoining regions

These regions may hold the key to the start of hive beekeeping with *Apis cerana* in certain parts of Asia not yet discussed.

The river Indus, nearly 3000 km long, rises in Tibet. Figure 29.5a shows the upper Indus basin, with mountain valleys in the Hindu Kush and extreme western Himalaya region, now in India, Pakistan and Afghanistan. Valleys at altitudes between 1000 and 1500 m had rather a temperate climate and many flowering plants, and were favourable for *A. cerana*; this was the only honey bee present and it was larger and more productive here than in the plains. When I first visited the region in 1980, I found to my astonishment that some of the hives and other beekeeping equipment resembled those I knew only in the eastern Mediterranean.

Jhelum valley in Kashmir, India

In 1980 F.A. Shah and his father A.M. Shah showed me the traditional beekeeping and equipment used round Srinagar in Kashmir, where there had been about 50,000 traditional hives until the tracheal mite *Acarapis woodi* killed many colonies in 1962. All traditional hives were horizontal, and closed at the front except for the flight entrance; honey combs were cut out from the back with a sickle that had a serrated edge. My greatest surprise was to find fired pottery hives similar in shape and size to those excavated in Greece (Section 23.21); like the Greek hives they had shallow incisions over half the circumference of the interior, which were, however, rather more faint and sparse. Flight entrance holes were bored in the rounded closed end of the hive (Figure 29.5b, *left*), and a potter who produced these hives told me that he made the holes before firing. Flight holes in this position are not known in excavated or recent hives in Greece itself, but see Section 22.22(f) and (g) concerning hives in Crete up to Byzantine times.

Another hive (Figure 29.5b, *right*) was a cylinder of sun-dried mud mixed with straw, with the flight

Figure 29.5b Two horizontal hives, near Srinagar, Kashmir, 1980 (photo: E. Crane). *left* Pottery hive similar to Figure 23.2c, but with the flight entrance in the closed end. *right* Hive of sun-dried mud and straw.

entrance in the flat front hive closure (as in excavated Greek hives). Still another, woven from willow twigs (*Salix alba*), is shown in Figure 29.5c.

For the honey flow, an extension holding up to 5 combs might be attached with mud at the back of any hive except a log. The extension might be a cylinder of mud and straw or – as in Figure 29.5c – a shallow woven wicker basket of a type used for many agricultural purposes.

Sometimes earthenware pots were embedded horizontally in a free-standing mud wall, with the flight entrance in the lid. Both woven and mud hives were also kept on shelves in the thickness of outside house walls, up to 10 or 20 in one house. Honey combs were harvested from inside the house after the back hive closure was removed, and any flying bees escaped through the unglazed windows. From outside, only the flight holes were visible, as in Figure 32.2b. Crane (1983a) and F.A. Shah (1984) published further descriptions and photographs of these hives.

My second surprise was that honey combs were marketed in a shallow red earthenware dish, covered with a similar dish inverted and sealed on with mud (Figure 29.5d). I knew such containers only from paintings on the wall of tombs in Upper Egypt from around 1450 BC (Figures 20.3b, 54.3a). The shape and colour of the Kashmir and Ancient Egyptian dishes were the same.

East of the Indus, bees were also kept in hives in

Figure 29.5c Woven horizontal hive with the flight entrance at the centre of the closed end; also with a (dark) woven basket as an extension; near Srinagar, Kashmir, 1980 (photo: F.A. Shah).

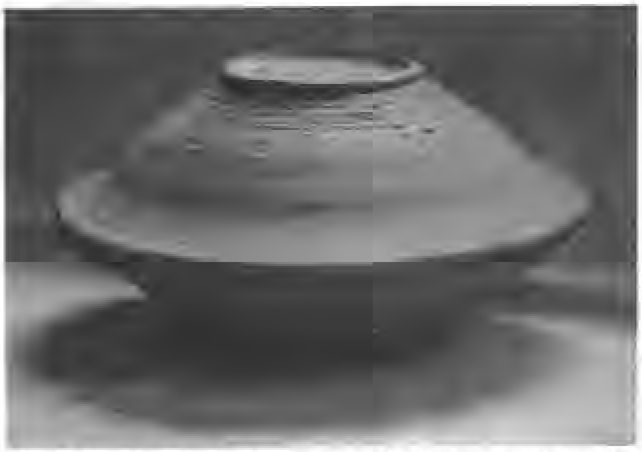


Figure 29.5d Pair of red pottery vessels used as a container for comb honey, Kashmir, 1980 (photo: E. Crane). Compare this vessel with those on the left in Figure 20.3b.

Figure 29.5e Beekeeper at Bahrain, upper Swat valley, Pakistan, holding a hive extension of sun-dried mud (photo: E. Crane). The flight entrance to one of his hives is on the right.

the valley of the Kaghan which drains into the Jhelum river.

Valleys of Swat, Chitral and Panjkora, Pakistan

Some 100 km west of the vale of Kashmir, *A. cerana* was widely kept in hives in the Swat valley up to about 2200 m (i.e. above Bahrain), and its side valleys. Farther north-west, similar beekeeping was done in the valleys of the Chitral, Panjkora, Kalash and its tributaries. Khalid Khan of Peshawar and Jehan Gir Khan of Khwazakhela in Swat showed me traditional beekeeping in the Swat valley in 1989 and 1993. Traditional hives were used horizontally, and an extension similar to hive A (below) was sealed on with mud to hive A or hive B.

A. cylinder of sun-dried mud (like a local bread oven) placed on its side;
B. fired water pot on its side;
C. woven cylinder of willow on mulberry stakes, coated inside and out with clay;
D. log – in higher parts of Swat.

Hive A was made by building up an open-ended cylinder from a horizontal surface, using coils of wet clay. It was about 40 cm in internal diameter and 45 cm high (long). The open outer end was placed against the inside of the house wall, and a hole made through the wall to provide a flight entrance; the inner end was closed with a piece of wood or cardboard. Figure 32.2b shows the flight entrances of three such hives. Swarms occupied the hives in August/September and built combs in any direction. When a hive was full, a similar extension was sealed on to the inner end with mud; see Figure 29.5e. An extension was sometimes fitted telescopically. Both the hive and any extension had to be supported, for instance by a wooden shelf or iron stand. To harvest honey, the beekeeper removed the end closure (then at the back of the extension), blew in smoke to drive all the bees into the original hive, and then removed the extension freed from bees. He also cut all honey combs except one from the hive; the bees would eat the remaining honey before they absconded to higher land where flowers were starting to bloom.

The log hive D was used in the higher parts of Swat, and round Dir and Alahi, where there were many trees. A log about 90 cm long, often from *Cedrus deodara*, was cut in half lengthways and hollowed out except at one end; 20 cm was preferred for the internal diameter, but it depended on the tree. The log was put together again and inserted horizontally through a house wall; the (open) inner end, which protruded, was closed with a disc of wood that could be pushed inside to reduce the hive size when a colony was small.

Eastern valleys of Afghanistan

Apis cerana is present in the centre and east of Afghanistan, including valleys drained by tributaries of the Indus (Schneider & Djalal, 1970; Nogge, 1974). Aseel Khan, from the Kolman valley west of Jalalabad, told me in 1989 that almost every house there had 4 or 5 traditional hives of *A. cerana* before the war started in 1979. Hollowed logs were embedded through a house wall (70-80 cm thick), each end protruding. The front (outside) end was closed by a wooden disc pushed back level with the wall, so that the flight holes in it were protected against snow. The back end inside was closed by a wooden board fitted with a handle. Bees built combs along the length of

the hive. Beekeepers used no swarm control or other colony management, and had no special tools. At harvest time, they took honey comb but left brood comb. In Agru in Nuristan north of Jalalabad, log hives were embedded along the length of the house wall, with the flight entrance in the outer long side (Crane, 1983a, Figs 218, 219).

The western boundary of *A. cerana* was in Afghanistan; Baluchistan and other desert areas separated this bee from *A. mellifera* in Persia (Iran), and Section 21.41 discusses recent traditional hive beekeeping there.

Origins of beekeeping in the upper Indus basin

The richness of the traditional beekeeping in this comparatively small region raises questions about its origin.

From around 2500 BC until about 1750 BC when it was destroyed, an important civilization flourished about 1000 km south of the high valleys discussed above – in the plains of the lower Indus, with major centres at Mohenjodaro and Harappa. The hive bee *A. cerana* cannot now survive in the area because of the heat, drought and lack of forage, and it seems to me likely this civilization could not have kept the bees in hives (Section 20.2). Honey and wax could have been obtained from natural nests of *A. florea* which is especially well suited to the hot dry conditions in the area; *A. dorsata* now lives in parts of it (Muzaffar & Ahmad, 1989).

Zain-ul-Abidin (1420-1470) was an early Muslim ruler of Kashmir who followed after a number of Hindus. He brought many craftsmen from the Middle East and made various agricultural introductions, and F.A. Shah (1984) suggested that he also introduced beekeeping. My own observations in the upper Indus basin, and discussions with historians and archaeologists, lead me to suggest that hive beekeeping had been introduced from the Middle East much earlier. Alexander the Great, King of Macedonia, advanced with his army through the region after he crossed the Hindu Kush in 327 BC; Hammond (1989) described the campaigns during his passage through Bactria (now partly in Afghanistan) and the valleys of the Panjkora, Swat (in winter 327/326 BC) and the upper Indus. Alexander himself reached the Jhelum valley, although not what is now Indian Kashmir farther east, but he had diplomatic relations with Abisares the ruler of central Kashmir.

Wounded soldiers who had to remain, and later Greek colonists who settled in the region, would have been accustomed to eating honey obtained from hives, and I think it is likely that they started to keep bees in the type of hive they knew in Greece – but necessarily used the local hive bee *Apis cerana*, which did well in the sheltered temperate valleys. Hammond (1990) endorsed this view. The upper Indus basin was lost to Macedonian rule about 300 BC, but Graeco-Macedonian rulers from Bactria regained control of it, and in later centuries these valleys were relatively undisturbed. In recent times most traditional hives were of plant materials, but some hives and extensions were made of mud or clay, and these show many similarities to hives used in Greece in Alexander's lifetime; see Figure 23.2a(2). Another link with eastern Mediterranean beekeeping in early times is the similarity between containers for honey combs used near Srinagar in the 1980s (Figure 29.5d) and in Egypt around 1450 BC (Figure 20.3b).

29.6 The rest of the Indian subcontinent

In 1882 a detailed record was made of bees and their use throughout the region under British rule (present India, Pakistan, Bhutan, Bangladesh and Burma). This resulted from the initiative of John C. Douglas, who worked for the Indian Government Telegraphic Department and was an amateur beekeeper. In September 1881, while on leave in London, he wrote to ask the Secretary of State for India for information to enable him to encourage beekeeping in India by both Indians and Europeans. The Revenue and Agricultural Department in India thereupon sent Douglas's questions to Governors and Chief Commissioners in the different regions, and the replies were published verbatim in *A collection of papers on beekeeping in India* (India, 1883). They described the honey-storing bees, honey collection from natural nests and, in the few places where it existed, traditional hive beekeeping. Sections below quote from some of the replies. The movable-frame hive, and European *Apis mellifera*, were not then present in India, but John Douglas introduced both soon afterwards, and in 1884 he published a book on beekeeping.

29.61 Himalayan and sub-Himalayan regions

Traditional hive beekeeping which now exists in these regions seems impoverished compared with that in parts of eastern Asia or in the upper Indus basin. Perhaps it existed, but did not seem noteworthy to travellers and recorders in comparison with the collection of *Apis dorsata* combs from high trees or dangerous rock faces. And *A. dorsata* nests yielded much honey, so there may have been little

incentive to improve yields from *A. cerana*. No early records have been found, and even recent ones are scarce. Muttoo had noticed hive beekeeping on his travels 'from Kashmir in the west to Assam border in the east, throughout the Himalayan range, wherever habitation exists'; he could find no information as to its age. Verma (1991) discussed many present-day aspects of beekeeping in the Himalayan region.

North-west India

In Uttar Pradesh beekeeping was usually most common at altitudes between 1000 and 1700 m. A colony could produce more honey above 1700 m, but bees survived the winters better below 1500 m (Melkania *et al.*, 1983). In forested areas above about 1800 m, hives were likely to be horizontal logs made to open at one end or both. They were commonly hung under the eaves of a house or outbuilding; if on the ground, large stones were laid on them as a protection against bears (Muttoo, 1954). Hives of various sizes were also made of wooden boards; the side opposite the flight entrance was sealed on with mud, and removed to take the harvest.

In most places beekeepers took honey twice a year. They knew approximately when to do it, and calculated which day would be auspicious for the operation. Smoke from an old rag was used to 'frighten away' the bees. In some places one or two combs were left for the colony during the dearth season, and bread and molasses might be inserted in the hive, but the colony rarely survived and the hive would await occupation by a swarm some months later. Muttoo made no mention of methods to entice bees to occupy bait hives, as described in Section 29.41.

Nepal

In the Khasa Kingdom in Nepal (1000-700 BC) a tax was imposed on honey. Other peoples migrated there from the western Himalayas and the Indian plains, and also Mongoloid peoples from Tibet. Hindu kingdoms were established in the 1600s. It is not known when hive beekeeping with *Apis cerana* was started, and this was probably always at a primitive level. As in India, more honey and wax could be obtained from the large *A. dorsata* nests.

Between Butwal and Muktinath in central Nepal, Wadhi (1961) found log hives at 1100 to 2300 m, placed under house eaves or projecting rocks. A house usually had one to three, but some as many as eight. The hives were put out empty and might remain so for quite a long time. In 1987 Nakamura found that in some parts of Nepal over half the hives were unoccupied, and their owners were known as 'waiting beekeepers'. Wild colonies were brought from a nearby forest to put in log hives, but they might then abscond. Or an empty hive was left near a wild colony in the forest, which then 'shifted to the log hive within a short time', and was taken home. Beekeepers had little knowledge of their bees, and accepted without question the seasonal absconding and swarming, and the period when hives were empty. However, Vries (1996) was told that some beekeepers captured scout bees to get a swarm to settle in a hive. As with many other activities in Nepal, bees were handled only on days that were auspicious for this purpose.

Log hives I saw in 1984 were 30 cm or more in length and 17-26 cm in diameter, with the flight entrance in the long side. A wooden board plastered on each end was removed when honey combs were taken; hive extensions were unknown. Bees were also commonly hived directly in wall recesses (Section 16.5).

Honey yields were higher in west Nepal than in the east where the climate was drier and the land less forested. Traditional beekeepers I met in 1984 and 1992 greatly valued the brood that was harvested with the honey. After squeezing out the honey for eating later, the sweet mixture (brood, pollen and wax, sticky with honey) was shared among family and friends and eaten straight away (Figure 51.6a). As in other Hindu cultures, honey was considered sacred and was used in religious ceremonies and functions, as well as in Ayurvedic medicine. Beeswax was – and still is – used for lost-wax casting of brass (Section 49.43).

Tibet, Bhutan and Sikkim

Tibet, now an Autonomous Region of China, is on the northern border of all the other regions discussed in this Section. It was Buddhist from the 600s, and had no beekeeping tradition. Khando Chazotsang, niece of the Dalai Lama, wrote in 1980: 'There was no beekeeping as such in Tibet. ... In eastern Tibet I am told that a few people did raise them; the bees were initially attracted to hollowed trunks of trees to which buttermilk had been applied. When the colony had become large enough the honey was taken, of course killing many bees in the process.'

In the 1900s, people of Nepalese origin in the south, who collected honey from *Apis dorsata* nests, sometimes kept *A. cerana* in log hives such as were used in Nepal. Bradbear (1986) found log hives, box hives and wall hives. Honey was valued as a food and

medicine, and beeswax used for strengthening sewing threads, and rubbed over cloth as it was woven to bind the threads together, but no information was found for past centuries. Verma (1992) gave background information about possibilities for beekeeping in Bhutan.

Sikkim, now a protectorate of India, is a tiny mountain kingdom between Nepal and Bhutan, where Buddhism is the state religion. It was peopled by the Lepcha who are thought to have come from Assam and Myanmar in the east, and the Bhutia of Tibetan origin, together with Nepalese who now form 75% of the population. Any beekeeping is likely to have followed the same pattern as in Bhutan. It was reported in 1890 that Lepcha collected honey combs from nests on a rock face (Section 10.23). In Darjeeling, just south of the border in India, Nepalese people, Bhutia settlers and Lepcha all kept bees in hollowed logs (India, 1883, Report 98T). E.R. Durnford (India, 1883, p. 81) added that Nepalese beekeepers harvested honey at daybreak after a dark night with no moon; the bees were stupefied by smoke, and comb 'cut away with ease, a portion of it being left for the bees'. Colonies flourished best at about 1500 m.

29.62 Indus and Ganges plains and peninsular India

Three types of hive were used in the plains (Muttoo, 1954). Disused and sometimes damaged water pots were put out for occupation by swarms; when a pot became heavy it was broken to get at the combs inside, and no attempt was made to save either hive or bees. Bees might be put into a basket of any shape or size, plastered over with mud to protect it and to seal up any cracks. Rarely, an inverted wooden 'cup' was used in the same way as a skep.

The use of earthenware pots as hives was recorded in Coorg (India, 1883; Muttoo, 1954), and I was shown one in 1980; entrance holes were pierced in the side, and the wide mouth was placed downwards. At swarming time the pots were rubbed inside with wax and taken to the jungle, where swarms would occupy them within 10-12 days, and they were then brought home. Later on, honey combs were removed after dark, bees being first blown aside at the mouth of the hive. Any larvae in harvested combs were eaten as well as the honey. A report in 1887 *British Bee Journal* said that another pot was usually added later over the first (above an access hole), but in 1954 Muttoo rarely found honey extensions on this hive. Pots were also used on the east coast, sometimes mouth to mouth.

The 1883 reports on India give the impression that in many parts of the peninsula there was no traditional hive beekeeping, and Svensson found the situation similar in 1992.

29.63 Bangladesh and Sri Lanka

Bangladesh was East Bengal in India, then East Pakistan from 1947 to 1956. It occupies the combined delta of the Ganges and Brahmaputra rivers, between Bihar and Assam (in India) and a strip of higher land to the south that adjoins Myanmar. The people are now mainly Muslim. Beekeepers working on recent aid projects found no traditional hive beekeeping. Svensson (1988) could not find any evidence of it in recent times 'except for one report about clay pots used in the Khulna area' east of Calcutta.

Sri Lanka (Ceylon) is a mountainous island about half as large as Nepal, in which Buddhism was introduced in the 800s. According to Drieberg (1920), farmers practising slash-and-burn agriculture hung up clay pots in trees during the swarming season (March/April) to attract passing swarms. The pot was sometimes treated with smoke from resin, and its mouth was smeared with honey and wax. In July/August the bees were smoked so that the honey combs could be taken, and often neither pot nor bees survived the process.

29.7 Factors affecting the development of traditional hive beekeeping in Asia

Previous Sections show that traditional hive beekeeping with *A. cerana* developed – to a primitive or an advanced level – in some (but not all) regions of Asia where the inhabitants led a settled existence practising agriculture. Possible causes of this regional disparity are discussed here.

Presence of other honey-storing bees

In general, people seem to have obtained honey and wax from whatever bee in the area gave the highest yield, almost regardless of the danger or pain involved. In parts of Asia where *A. dorsata* lived, it was the most prolific yielder, and its presence in a region was almost certainly a major factor in inhibiting the development of hive beekeeping with *A. cerana* (Crane, 1989a). Table 29.7A shows that most regions where hive beekeeping developed early, and made some advances, were outside the tropics or at rather high altitudes within them where it was too cold for *A. dorsata* to survive: in China (the north and moun-

tains in the south), Korea, Japan, and the upper Indus basin. In the hot plains *A. dorsata* did well, whereas *A. cerana*'s smaller body size and smaller colonies made it less productive. These distinctions would help to account for the relative absence of traditional hive beekeeping in much of peninsular India, and its late start in such areas as the Philippines and the coastal plains of Malaysia.

Table 29.7A

Probable first date of traditional hive beekeeping (with *Apis cerana*) in countries of Asia east of Persia

Revised from Crane (1995 [written 1988], 1989a).

Where the date is not known, yes/no indicates whether or not traditional hives were probably used.

Table 36.4A gives dates for movable-frame hives, and for the use of *A. mellifera* in hives.

Section	*Country/region*	*Date*
North-east Asia		
29.2	China	pre-200
29.2	Taiwan	?c.1700
29.31	Korea	pre-643
29.31	Far-Eastern Russia	1800s
29.32	Japan	1160
South-east Asia		
29.41	Vietnam	256-290 or 700s
29.42	Laos	no
29.42	Cambodia	no
29.42	Philippines	no
29.43	Thailand	early 1900s
29.43	Myanmar	pre-1984
29.43	Assam	pre-1883
29.44	Indonesia	1848
29.44	Malaysia	1938
Western Asia		
29.5	Kashmir	?c.300 BC
29.5	Upper Indus basin	?c.300 BC
	rest of Pakistan	pre-1883
29.5	Afghanistan	yes
29.61	North-west India	yes
29.61	Nepal	yes
29.61	Tibet	?no
29.61	Bhutan	?no
29.62	peninsular India	pre-1883
29.63	Bangladesh	?no
29.63	Sri Lanka	pre-1855

European *A. mellifera* was introduced into regions of Asia east of Persia from the late 1800s (Section 36.41), usually at the same time as movable-frame hives. Where it did well, honey yields from *A. cerana* were often reduced, and beekeeping with *A. mellifera* in movable-frame hives became more profitable, so traditional beekeeping was likely to decrease. (*A. mellifera* has a larger body size and a longer foraging range, builds larger colonies and stores more honey. Also colonies are unlikely to abscond.)

Stingless bees are present in the tropics of Asia, but they yielded less honey than *A. cerana*, and were not often kept in hives (Section 30.6).

Alternatives to honey as a sweetener

Sugar cane (*Saccharum officinarum*), grown in many lowland tropical regions, probably originated in India and is mentioned in Hindu mythology; *Saccharum* appears to be derived from Sanskrit *karkara* (Singer *et al.*, 1954/58). The sugar maltose, probably obtained from rice or wheat, was mentioned in China during the Chou dynasty, c. 1027-265 BC (Appendix 1). Certain palms and some other trees produced a sweet sap which was collected in many parts of south-east Asia. The use of any of these sources of sugar could have served as a disincentive to beekeeping.

Religion

A number of important early religions originated in Asia (Chapter 54), during the period when honey was obtained from bees' nests. Honey was highly regarded in almost all of them (Table 54.2A), but the taking of life – even of insects – was proscribed in Buddhism and Jainism. Islam postdated hive beekeeping, reaching the Upper Indus basin during or after the AD 600s, and it also regarded bees and honey highly.

Transmissions between different regions

It was suggested in Section 20.2 that the arid climate in the lower Indus valley probably precluded hive beekeeping with *A. cerana* during the Ancient civilization there, and Section 52.12 discounts certain passages in the *Rig-Veda* as evidence that hive beekeeping was practised by Aryan people who moved into the Indus and Ganges valleys about 1700 BC. It is suggested in Section 29.5 that the use of hives was probably first introduced shortly before 300 BC from the Middle East to the upper Indus basin where *A. cerana* flourished. The style of hive beekeeping used there does not seem to have been transmitted further east into the main Himalayan region between the basins of the Indus and Brahmaputra rivers, or into peninsular India, but both these regions are separated from the Indus basin by the 3000-m Banihol Pass, and the presence of

the more productive *A. dorsata* in them would also inhibit the development of *A. cerana* hive beekeeping.

Hive beekeeping existed in China from AD 25-150 or earlier, and in Vietnam by the AD 700s and probably much earlier. It almost certainly spread from China to Korea and thence to Japan.

Farther south, it seems likely that methods of hive beekeeping were transmitted by certain migratory peoples – especially the Kinh (Mulder, 1995) – along mountain ranges that extend westward from Tonkin in north Vietnam and possibly Yunnan in China. The transmission reached the northern part of Myanmar and neighbouring Assam, but perhaps not the main Himalayan region. At various places along this route, traditional beekeeping is known to have incorporated several special techniques. One was tethering the queen temporarily in a newly populated hive to prevent the bees absconding; the practice is recorded in parts of north Vietnam, north Myanmar, Assam, also in Nepal and eastern Java (Gelpke, 1896; Vries, 1996) and Ko Samui in Thailand. Some hill peoples in north Vietnam – and some in Nepal (Vries, 1996) – were also skilful in capturing incoming swarms, by catching scout bees approaching a bait hive and shutting them inside for a short period. The practice was described in China before AD 300 (Section 29.2). I have not heard of these techniques being adopted with *A. mellifera*, and they may not be possible except with *A. cerana*. Further, from the 1800s or earlier, some hill peoples in north Vietnam and possibly south China fitted upright logs with top-bars, so that these became movable-comb hives (Section 39.4). I hope that additional evidence will be sought in these mountains which form an eastern extension to the Himalayas, so that a more complete synthesis can be made of the history of the remarkable traditional hive beekeeping in the region.

30

Traditional Hive Beekeeping with Stingless Bees

30.1 The bees, peoples and regions

30.11 Stingless bees kept in hives

Stingless bees (Meliponinae) are social bees, which nest in cavities. Their evolution and distribution – in most of the world's tropics and some adjacent subtropical regions – are summarized in Sections 2.2 and 3.6. The nests were probably hunted wherever they occurred (Chapter 11) and tended by a few peoples (Section 17.2), but their relative value to man was different in different continents. In the Old World tropics and subtropics stingless bees usually played a minor role, since the yield from a nest of most species was small compared with that from a nest of honey bees in the same area. In the Americas and Oceania there were no honey bees until they were introduced by man; stingless bees were the only source of beeswax, and of honey except in regions with honey-storing wasps or honey ants (Sections 3.8, 3.9). In general, methods for exploiting stingless bees followed the same sequence as that for honey bees, but rather sporadically.

The majority of the 500 or more species of stingless bees live in the American tropics, and Table 30.1A lists 55 species and subspecies known to have been kept in hives: 29 of *Trigona*, 24 of *Melipona*, and two of other genera. The array of horizontal combs which constitute the brood nest of many species consists of upright brood cells opening at the top as in Figure 3.6a, and is usually near the flight entrance; pollen and honey pots of soft cerumen (a mixture of wax and propolis) are built on both sides, or occasionally on only one.

Traditional hive beekeeping reached its highest level in Mesoamerica (Figure 30.1a), where the species *Melipona beecheii* was widespread and well suited for the purpose, and the Maya lived in an organized civilization – at a time when South American peoples, at the hunter-gatherer stage, obtained honey from natural nests.

General sources of historical information relating to the Americas include the following:

- Yucatan: Calkins (1974), and a 1990s project, *Sostenibilidad Maya* at the Universidad Autonoma de Yucatán, which taught and also published instructions on hive beekeeping with stingless bees.
- Mesoamerica: Schwarz (1949), Kent (1984b), Dixon (1987), Brand (1988); archaeology, Wallace (1978), Sidrys (1983).
- all tropical America: Nordenskiöld (1929b, 1930, 1931, 1934), Schwarz (1948).

Nogueira-Neto (1997) gave much general information, especially on 'rational' hives which he and others devised (Section 30.53). Section 36.81 refers to attempts to overwinter stingless bees in hives in temperate climates, and Crane (1992) discussed some recent developments.

30.12 Background to Mesoamerica and the Maya people

Figure 30.1a shows the extent of Mesoamerica, a Maya-influenced culture area in which peoples shared many common characteristics. These included: the Maya language written in a hieroglyphic script; ritual and religious concepts; a 260-day calendar; domesticated plants. The culture area was centred in the Yucatan peninsula where spectacular temple pyramids and complex ceremonial buildings were built, and surviving remains testify to very high achievements attained without use of the wheel or metal tools. Yucatan, now divided between Mexico, Guatemala and Belize, is by far the most important region in the history of hive beekeeping with stingless bees. The hive bee of the Maya (*Melipona beecheii*) was known as *colecab* (lady bee), and beekeeping with it apparently originated independently of hive beekeeping with honey bees in the Old World.

A substantial amount is known about past Maya beekeeping, thanks to archaeological finds as well as written accounts by Europeans after the Spanish conquest began in 1519. Corn (maize, *Zea mays*) provided the principal food in the Maya civilization, and

Table 30.1A

Some stingless bees (Meliponinae) that have been kept in hives

Main sources: Crane (1990a), Kent (1984b), and (marked N) Nogueira-Neto (1970).

Names of subgenera are in brackets. Nest size can vary from region to region.

Species	*Size of nest*	*Example of region where kept*
Lestrimelitta (Cleptotrigona)		
cubiceps		Angola
Melipona:		
atratula		Bahia (Brazil)
beecheii	small to large	Mexico to Costa Rica; Cuba; Jamaica
bilineata		Bahia, Brazil
compressipes		Colombia
compressipes manaosensis		Brazil
dorsalis		Bahia, Brazil
fasciata	large	Mexico; Costa Rica; Panama
fasciata guerreroënsis	large?	SW Mexico
fasciata rufiventris	large	Brazil
favosa		Trinidad
favosa phenax	medium	Panama
fulginosa (= *flavipennis*)	large	Costa Rica
mandaçaia		Brazil
marginata	small	(N) Brazil
nigra	large?	(N) Brazil
pseudocentris pseudocentris		Brazil
quadrifasciata	large	(N) Brazil
rufiventris		(N) Brazil
schencki picadensis	large	Brazil
schencki schencki	large	Brazil
scutellaris	large	(N) Brazil
seminigra merrillae	large	Brazil
subnitida		Brazil
trinitatis	medium	Trinidad
Meliponula bocandei		Angola; ?Gambia
Trigona:		
(Axestotrigona) erythra togoensis		Angola
(Cephalotrigona) capitata	large	(N) Mexico; Costa Rica; Brazil
(Friesella) schrottkyi	very small	(N) Brazil
(Hypotrigona) gribodoi		Angola
(Nannotrigona) testaceicornis	medium	Brazil; Costa Rica
(Nannotrigona) testaceicornis perilampoides	medium	W Mexico
(Oxytrigona) tataira	large	Brazil
Trigona: (continued)		
(Partamona) cupira	medium/large	Yucatan (Mexico); widely elsewhere
(Plebeia) emerina	small	Brazil
(Plebeia) mosquito	small	Brazil
(Plebeia) remota	small	Brazil
(Scaptotrigona) depilis		Bolivia
(Scaptotrigona) pectoralis	medium	Yucatan; Costa Rica
(Scaptotrigona) postica	large	(N) Brazil
(Scaptotrigona) tubiba	large	(N) Brazil
(Tetragona) clavipes	large	(N) Brazil
(Tetragona) mombuca	large	Brazil
(Tetragona) nigra	medium	Yucatan
(Tetragona) silvestrii	very small	Brazil
(Tetragonisca) angustula =*(Tetragona) jaty*	medium	Yucatan; Costa Rica; Brazil; Bolivia; El Salvador
(Trigona) amalthea		Brazil
(Trigona) corvina	large	Costa Rica
(Trigona) dallatorreana		Brazil
(Trigona) fulviventris	large	Honduras
(Trigona) mexicana	medium	Mexico
(Trigona) spinipes	medium	Brazil
Trigona (subgenus not known):		
flaveola		Bahia (Brazil)
geniculata		Bahia (Brazil)
muscaria		Bahia (Brazil)

there is much to suggest that *colecab* was next in importance in the people's lives and rituals, since it provided honey and also *balche*, their alcoholic drink. The Maya inherited many ideas and inventions from Olmec and other previous civilizations, but the earliest known evidence of hive beekeeping anywhere in the Americas is from the Preclassic Maya Period (300 BC to AD 300). In Table 30.2A, site 7 and possibly site 6 in Belize, and site 12 near Mexico City on a Maya trade route, are dated to this Period.

The later Inca and Aztec civilizations flourished between the 1100s and 1500s, but were mostly at altitudes too high for the survival of stingless bees. Nordenskiöld (1929b) said that there was 'conclusive evidence of beekeeping having been unknown' in the Inca kingdom in Peru. Thompson (1970) noted that early Spanish records lacked references to beekeeping in the highlands in Guatemala and other parts of Mesoamerica, and suggested that these were also too cold for the bees.

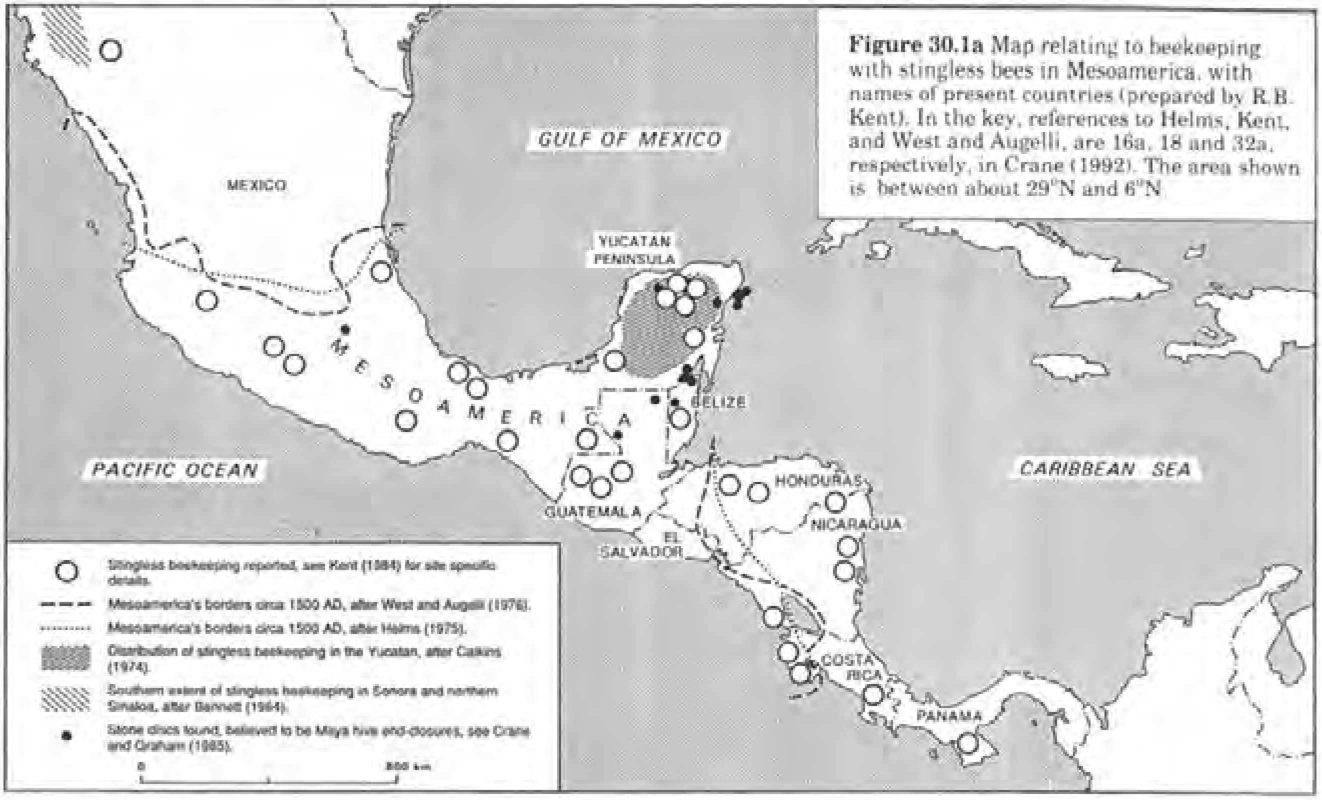


Figure 30.1a Map relating to beekeeping with stingless bees in Mesoamerica, with names of present countries (prepared by R.B. Kent). In the key, references to Helms, Kent, and West and Augelli, are 16a, 18 and 32a, respectively, in Crane (1992). The area shown is between about 29°N and 6°N.

30.2 The Maya in the Yucatan peninsula

30.21 The archaeological record

The Maya in Yucatan now use a horizontal hollow log as a hive, with a central flight entrance and a closure at each end: a disc of wood or soft stone, cut or chipped away to fit inside the log. Figure 30.2a shows hives of this type. Evidence that the Maya used similar hives at several periods more than a thousand years ago is provided by the excavation of stone discs, as described below. Figure 30.2b shows some of them, and Table 30.2A lists the sites. The discs are similar to hive closures in use today (e.g. Freidel, 1976). In all, 255 discs were excavated on the offshore island of Cozumel, others in mainland Yucatan, and one was near Mexico City outside the

Figure 30.2a A few Maya log hives of *Melipona beecheii* on an A-shaped rack, Yucatan, Mexico, *c.* 1980 (photo: G.F. Townsend). Figure 30.2e shows the construction of an A-rack.

Figure 30.2b Thirteen limestone discs dated 300 BC to AD 300, found at Chan Chen, northern Belize (photo: J.M. Andresen). See Table 30.2A, site 6. Most discs have diameters between 8 and 10 cm and are 3-4 cm thick.

Table 30.2A

Stone discs found at Maya sites, considered to be end-closures for log hives

Based on Crane & Graham (1985).

Period

c. 300 BC - AD 300	Late Preclassic (LPe)
c. AD 300-900	Early Classic (EC), Classic (C), Late Classic (LC)
c. AD 900-1520	Postclassic (Po), Late Postclassic (LPo)

Ref. no	*Site*	*No. discs*	*Material*	*Period*	*Ref.**
Cozumel island					
1	Aguada Grande	c.73	coral/limestone	LPo	F
		c.30			W
2	Buena Vista	87	coral/limestone	LPo	F
3	San Gervasio	37	coral/limestone	LPo	F
	also other sites, giving a total of 255 for Cozumel				W
Yucatan peninsula					
4	Tulum, Quintana Roo, Mexico	1	?	?	Ru
5	Mayapan, Yucatan, Mexico	55	inferior quality stone	Po	P
6	Chan Chen, Corozal, Belize	37	limestone	LPo or LPe	S
7	Cerros, 15 km SE of Chan Chen, Belize	101	limestone	LPe	F
8	Santa Rita, Corozal, Belize	1	limestone	LC/Po	S
9	Altar de Sacrificios, Guatemala	?	soft limestone/ pumice/sandstone	LC	S
10	Barton Ramie, Belize	?	misc. ground stone	C	S
11	Uaxactún, Central Peten, Guatemala	6	v. chalky decomposed limestone	C	Rk
Near Mexico City					
12	Ticoman	2	stone	LPe	V

* F Freidel (1976)
S Sidrys (1976)
W Wallace (1978)

See Wallace for: P Proskouriakoff (1962)
Rk Ricketson (1937)
Ru Rubio
V Vaillant (1931)

Maya area but on a Maya trade route in Preclassic times.

Stone discs found by D.A. Phillips at Buena Vista in Cozumel (site 2) included 12 which could be matched in pairs for size and shape; most were 12-15 cm in diameter, and they were found in the positions shown in Figure 30.2c. The two of each pair were separated by a distance of about 50 cm, the usual length of a log hive used today (Wallace, 1978). These discs were probably the remains of part of an apiary; Figure 30.2e shows the type of apiary in current use.

Wallace (1978) and Sidrys (1983) presented in full the reasoning that led to identification of the discs as hive closures. It is unlikely that any wooden logs used for hives still survive from early times, but Figure 30.2d shows four of them ornamenting a fired clay censer (used for burning incense) found on Cozumel and dated to about 1450. The censer, in the form of an effigy of the Maya bee god Ah Mucan Cab,* shows hives with a central flight entrance and end closures.

*When *Apis mellifera* colonies were first brought to Yaxcaba in about 1900, the bees seemed so large, and produced so much honey, that many people were convinced that they were in fact the gods of *colecab*.

Between the hands of Ah Mucan Cab is a cluster of cells such as would be found in a hive.

Sidrys (1983) published fragments of other effigy censers, four of which possibly also represent Ah Mucan Cab. An early one, dated to between 300 BC

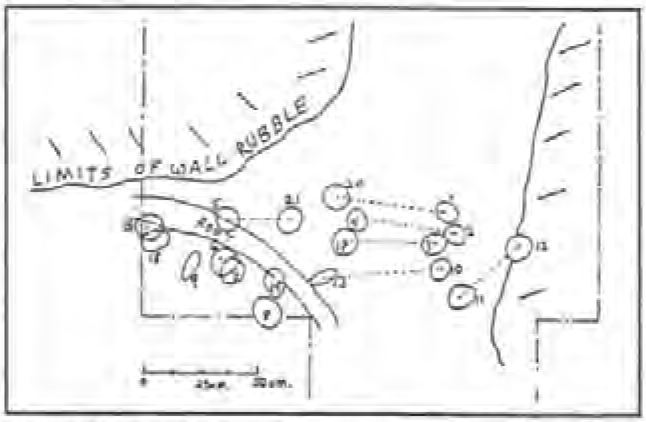


Figure 30.2c Plan of part of the excavated area at Buena Vista, Cozumel, showing locations at which stone discs were found (Wallace, 1978). See Table 30.2A, site 2. Dotted lines join 12 together in pairs likely to be the two ends of the same hive. Other discs (on the left) had been disturbed.

Figure 30.2d Incense censer from Cozumel, in the shape of the Maya bee god Ah Mucan Cab, c. 1450, in the Archaeological Museum of Yucatan, Mérida (Darchen & Darchen, 1978). See text.

and AD 300, was found at Chan Chen in northern Belize, at a site which yielded fragments of other censers, and also three stone discs that were probably hive end closures. They were all inside the base of a rectangular dry-stone wall about 1.4 x 1.2 m, which Sidrys suggests might have been an apiary. Burning incense near an opened hive may have repelled phorid flies; see Section 30.52.

30.22 Early written and pictorial records

Yucatan

The first officially sanctioned expedition from Europe to explore Yucatan was that by Francisco Hernandez de Córdoba in 1517. Grijalva, who was there in 1518, referred to beekeeping, and on 10 July 1519 Hernando Cortés wrote to the King of Spain about the island of Cozumel:

> The only trade which the Indians have is in bee hives, and our Procurators will bear to Your Highness specimens of the honey and the bee hives that you may command them to be examined. (Translation quoted by Calkins, 1974)

An account of the discovery of Yucatan, written by Bartolomé de las Casas between 1520 and 1561, included the passage:

> They [Spaniards] saw many wooden bee hives full of tame bees and much honey, of which they [Indians] brought to the Spaniards many gourds full. It was white and excellent. Here it may be made known that in no part of the Indies which have been discovered has any been seen where they have hives of tame bees, nor do they try to obtain them, except in the island of Cozumel or in Yucatan, which is mainland close to it. (Translation as above)

About 1550 Oviedo, who died in 1557 after spending 24 years in the New World, wrote a detailed description of the beekeeping found by the Spaniards around Chetumal (near Site 8 in Table 30.2A). It was quoted in Spanish by Nordenskiöld (1930) and in English by Calkins (1974):

> [The hive is] a log or piece of a hollowed-out tree, leaving it whole like the shape of a drum, and as thin after being constructed as the smallest finger of the hand, or as they want to leave it, and on the outside [is the] bark and [it is] very well carved [with] detailed figures and raised relief foliage ornamentation, and each hive has on it the sculptured sign of the owner, whose hive it is.*
>
> [Spaniards found] much and very good honey, and large apiaries with 1000-2000 hives in trunks of trees, well made, with their openings and entrances; and large is this beekeeping activity and commerce in honey there, and it is not inferior to that of Castile in colour and flavor; but the wax is black, like jet. ... [The hive] has the extremes plugged with a stone for each end, and very well plastered with mud. ... The bees enter and leave by a hole which is in the middle ... of the hive. ... The honey is deposited in pouches of wax, and these are swelled with it [Figure 3.6a] ... When they [the Maya] want to remove the honey and extract the hives, or whichever of them, they undo

*Compare the ornamented pottery hive in Figure 30.3a, published in 1839.

> that part of vessel near the right side where the pouches of honey are and puncture them, making a hole in them as thick or as thin as they want the flow of honey to be; thus through here it makes its course and it flows nicely and delicious and clean without any wax, as pure as if they strained it through a very clean sieve. [The beekeeping] is, indeed, a beautiful thing to see and contemplate, and there are very large areas of land devoted to it in the land of that honey, especially there [Chetumal].

In 1653 Cobo gave a little additional information from Yucatan.

> In New Spain the Indians, and even the Spaniards, keep these bees near their homes; however, they bring them from the forest in the same tree trunk they were living in, cutting it to the proportions of a hive .... The bees let themselves be handled ....

He also reported the following social customs. A deceased beekeeper's hives were inherited by his sons or, if he had none, by his brothers or male cousins (Roys, 1972). Any Yucatan peoples who 'were the cause of some conflagration of houses or farm lands, of bee hives, or of granaries of maize' were required to satisfy the judgment against them for destruction of another's property (Tozzer, 1941, from Landa's *Relación*, 1566).

Bishop Diego de Landa had arrived in Yucatan in 1549, seven years after the Spanish had conquered the Maya people there. In his *Relación de las cosas de Yucatán* (1566) he was fulsome in his praise of the 'diversity of plants and flowers which adorn Yucatan', adding that 'they give abundant food supply to the little bees for their honey and wax'. He also described the bees' combs, and how beekeepers harvested them. However, he was responsible for destroying most of the Maya writings then extant: 'We found a great number of books ... As they contained nothing in which there was not to be seen superstition and lies of the devil, we burned them all, which they [the Maya] regretted to an amazing degree and caused them affliction.' Only three Maya books survived; one is *Codex Tro-Cortesianus*, a hieroglyphic manuscript 7 m long divided into 112 pages, which was primarily a textbook of horoscopes to help the priests in making their divinations. Cappas e Sousa (1995/98) redrew 59 illustrations considered to represent hives, wax combs inside them, bees and bee gods. Figure 54.5c shows some others, and the Codex itself can be seen in the Museum of Archaeology and History in Madrid. One of the 1996 papers dealt with the *Codex Maia de Madrid*.

Between 1715 and 1830, of 81 men in the town of Tekanto whose material wealth was recorded, 32 owned hives, on average 35 each (Roys, 1943).

Bee ceremonies

These were an essential part of the beekeeper's seasonal bee management, and were accompanied by much drinking of *balche*, made by fermenting honey with bark of the *balche* tree (Section 48.5). Landa's *Relación* (1566) included a brief description of a ceremony: 'In the month of Zotz, the owners of hives of honey prepared to celebrate their festival ... They had for mediators the Bacabs ... They made many offerings, ... since the feast was held in order to obtain abundance of it. They ended it as usual with wine [*balche*] and enough of it, for the owners of the hives gave honey for it in abundance.' The second bee ceremony was held in the eighth month Mol (our December), so that the bees would be blessed and flowers provided for them. See also Sections 30.23 and 54.5.

Tribute and trade in Yucatan

Tribute lists for 1549 show that out of 173 towns and villages paying tribute to the Spanish, 163 paid in wax and 157 in honey. The Maya valued beeswax very much less than honey; they made torches from bundles of plant stems for lighting, and they did not use or cast metals. On the other hand the Spanish needed much wax for candles. The 1549 tributes included about 3 tonnes of honey and 277 tonnes of wax. Calkins (1974) estimated that this large amount of wax was equivalent to 0.57 kg per inhabitant in the region.

Wax from stingless bees was of lower quality than honey bee wax for making candles. Nevertheless during the mid-1600s it was one of the most important exports from Yucatan, ranking with salt, cotton cloth, indigo and hides. In later colonial times Vera Cruz was the main entrepôt for honey and wax from Yucatan, and it served much of highland Mexico. The wax – known as *cera de Campeche* – was the best beeswax produced in the New World until honey bees were introduced. Calkins (1974) calculated that the amount of wax traded through Vera Cruz decreased during the years 1801 to 1809, in general varying between 37 tonnes (1801) down to 0.9 tonnes (1808). But the trade continued until 1821 when Spanish colonial rule ended.

The end of Section 46.42 refers to tributes of honey in the rest of Mesoamerica.

30.23 Recent Maya beekeeping

After studying traditional beekeeping with *Melipona beecheii* in Yucatan, Calkins (1974) concluded that Oviedo's description from around 1550 (Section 30.22) was representative, accurate and 'for all practical purposes identical' to what he found in the 1970s.

According to Calkins's own observations, whenever possible the log hives were made from the soft and light wood of *Gyrocarpus americanus* (Hernandiaceae); its relative density was only 0.38, about the same as that of western red cedar (*Thuja plicata*). End closures were of stone or 'in a few instances' of wood, and they were sealed in place with *kan-kab*, a local cement-like red earth with a high lime content. If a household had five hives or fewer, they were hung under the eaves from a cross-beam. If it had more, the hives were always placed on a wooden A-shaped rack under an open thatched shelter of a standard type (Figure 30.2e). Either site provided some protection for the bees, and took up little space. In a shelter, up to 10 or 15 hives were placed on one side of the A-rack; if there were more than 15, both sides were used. Other stingless bees were occasionally kept in Yucatan, but in isolated hives distant from *M. beecheii* apiaries; they included *Trigona* (*Scaptotrigona*) *pectoralis*, *T.* (*Tetragona*) *jaty* and *Partamona* sp. (Kent, 1984b).

Redfield and Villa Rojas (1962) studied Maya life in detail in Chan Kom, a village in Mexican Yucatan half-way between Cozumel and Mérida. Their description of the hives and beekeeping was also very similar to Oviedo's. Hive closures were not of stone, but of wood held in place with dried mud. Apiaries were regarded as belonging to the bee gods; great care was taken not to injure or kill bees, and a man had to atone for taking the bees' honey or even for touching them. A ceremonial offering was made with part of the honey harvested, and some honey was always left in a nest. In addition to the regular seasonal ceremonies, one was performed when a hive was moved, or a new one established.

Weaver and Weaver (1981) made a detailed study around Yaxcabá, 30 km west of Chan Kom, and Figure 30.2f shows a hive prepared for harvesting honey. A major bee ceremony, carried out every four years to bless the bees, was recorded on tape in 1978. A shaman was found in a neighbouring village who was willing to preside, but it seemed unlikely that the necessary knowledge would survive for another such ceremony – traditional customs were dying out. Many beekeepers there had owned 400 colonies in 1930, and one had 103 in 1978. Most of them divided colonies in spring by transferring to an empty hive some torn-off pieces of brood comb from several hives, with the bees that were on them, and then shaking in a few extra bees. Two green twigs, slightly longer than the internal diameter of the hive, were wedged across it in an X-shape, just beyond the entrance. The brood comb was then inserted (close to the

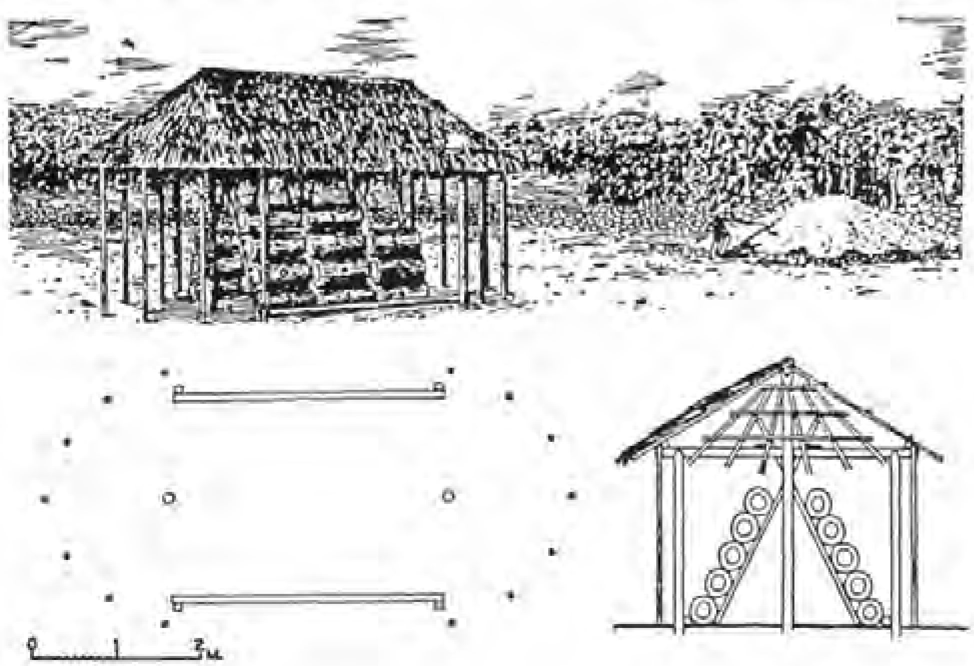


Figure 30.2e A-rack with log hives under a thatched shelter, Yucatan, 1920s (Wauchope, 1938). Drawing of shelter, plan and elevation.

Figure 30.2f Hive ready for honey extraction, Yaxcabá, Yucatan (Weaver & Weaver, 1981). With its end-closure removed, the hive is supported above a basket woven from vine stems, which will strain the honey when this is released by piercing honey pots visible within the hive.

entrance), with a second pair of twigs to clamp the comb in position. It is interesting to compare this operation with that in Sicily when a colony of *Apis mellifera* was divided (Figure 22.1e).

30.24 Why and how did hive beekeeping develop in Ancient Mesoamerica?

The Ancient Maya were the first people in the region to make substantial developments in agriculture – based on maize – and perhaps the development of hive beekeeping in Yucatan during the earliest (Preclassic) Maya period was part of this general development.

The earliest archaeological sites with evidence of beekeeping (Table 30.2A) are dated to the Late Preclassic Maya period (300 BC to AD 300), and there are sites from the Classic period in Belize and Guatemala, but most sites are from the Postclassic period (AD 900 to 1520), in the north of the Yucatan peninsula and on the island of Cozumel.

It is not difficult to understand the origin of the horizontal cylindrical hive with removable end-closures. In the wild, *M. beecheii* – the bee used in hives – builds a horizontal nest in a tree cavity, and a log containing a nest could be cut off and adapted as a hive. The development of the systematic use of log hives, uniform in style, approximate shape and size – and housing – was linked in some way with the Maya civilization: perhaps by opportunity afforded, or pressure imposed, or communication between people with access to colonies of the same bee in a relatively homogeneous region.

The presence of *M. beecheii* was almost certainly one important reason why hive beekeeping developed so well in Mesoamerica. This was the stingless bee most amenable to management in hives in an apiary, and it also gave worthwhile honey yields. A few other species of *Melipona* and *Trigona* were kept in hives in Mexico and Central America, but only occasionally (Kent, 1984b).

M. beecheii is characteristic of Mesoamerica, and closely associated with the region through which Maya influence extended. The lack of a substantial development of hive beekeeping elsewhere in the American tropics, in prehistorical or historical times, was probably due partly to the absence of a suitable hive bee.

30.3 Mesoamerica outside the Yucatan peninsula

No artefacts connected with past hive beekeeping are known from this area except the one at site 12 in Table 30.2A. Spanish records from the 1500s suggest that stingless bees were kept in Mexico in Jalisco province west of Mexico City and in the Balsas river basin (Guerrero), and they also give direct information about the use of hives in the Nicoya peninsula in western Costa Rica (Figure 30.1a). Almost all other records found about hives or beekeeping are from the 1800s or 1900s. However, in view of the close similarities between methods in the Yucatan peninsula in the 1500s and the 1900s, and between these and methods in some other parts of Mesoamerica after 1800, it seems likely that methods used outside the Yucatan peninsula may have been learned from the Maya at some earlier time.

Beekeeping in Jalisco in the west of Mexico was described by Oviedo (c. 1550). His account, quoted by Nordenskiöld (1929b), differed in only two details from that in most other areas: the log hives were

sometimes hung inside the houses, and the bees 'were as small as flies'. Part of the honey was used at home and part was bartered. Horizontal log hives were still used for stingless bees at San Marco in Jalisco in 1928, when Diguet photographed a row of about a dozen on a low wooden stand, covered with roof tiles.

Dixon (1987) located a number of early records from the Balsas river basin. About 1520, Cortés required peoples in the Valley of Mexico, south-west of present Mexico City, to make a record of tributes they had paid to the Triple Alliance consisting of the Aztec, Texcoco and Tlacopan. This *Matricula de tributos* shows that groups of communities within the Balsas basin provided together an annual tribute of nearly 2000 jars of honey, almost all of it from within the present state of Guerrero. Honey and wax were wanted by the Aztec in adjacent highlands where the climate was too cool for stingless bees. Cortés included honey and wax as important trade items in the great market of Tenochtitlan, the Aztec capital, and in 1578 Francisco Lopez de Gomara mentioned honey similarly. According to another list of tributes (*Suma de visitas de pueblos*, 1547-1551), the present state of Guerrero contained nearly half the 42 localities reported as paying wax tribute, and also all the 34 localities that provided honey tribute, which was payable every four months. Every 80 days the tribute area of Altimaxaque, associated with the town of Tlapa in eastern Guerrero, had to provide six donkey loads of honey and four of wax. These records do not mention beekeeping, but it seems likely that the tribute came from hives.

In the 1900s, *Melipona beecheii* and another species were kept in hives in the Balsas basin; logs containing colonies were transported from the forest and hung on outer house walls. Nordenskiöld (1929b) reproduced Starr's 1900 photograph of a house and hives of Mixtec people in the same province, and quoted his description of them:

> At Yodocono, San Bartolo and other towns, they keep many bees. The bee hives are cylindrical foundations made of sticks tied together, which are then wrapped in matting and hung to the sides of the houses or arranged upon supports over which protecting thatches are constructed.

Farther north, at Tépic in Nayarit province near the west coast, hives such as that shown in Figure 30.3a were used in the 1800s; the drawing was published by Jean-Pierre Huber, son of François, in 1839. There are not many records of such pottery hives, but Captain Hall (1824) described some that were ornamented with what he called 'monsters'. Colonies in hives were referred to as 'perpetual', and some in Tépic were said to have survived for over a century. A new colony could be started in a hive by transferring to it a small piece of brood comb and some bees, and the colony's final population would depend on the size of the hive. A fairly large hive could yield around 3 gallons of honey a year (14 kg).

Figure 30.3a Hive of fired clay with an ornamented flight entrance, of the type suspended outside houses in Tépic, Mexico (J.-P. Huber, 1839).

Bennett (1964) showed that Oviedo's 1550 account of beekeeping in a large settlement in the north of Mexico, called Chamola, must have been incorrect hearsay evidence.

A few records from the 1900s were found for countries south of Mexico. According to Wisdom (1940), the Chorti in Guatemala took a nest home from the forest (probably of a *Trigona* species), and planted wild shrubs and other flowering plants near it for the bees to feed on. In 1943 in Honduras, the Jicaque kept mostly *M. beecheii* in hives, but also probably *Trigona (Trigona) fulviventris* (Schwarz, 1948). Nordenskiöld (1929b) quoted Hartman's 1901 report that in San Salvador the Aztec were keeping two species of bees in 'small gourds suspended from the walls of their houses'. In parts of Nicaragua *M. beecheii* was kept in log hives stacked against a house wall (Kvarnbäck & Svensson, 1985).

Nicoya peninsula in Costa Rica

The Nicoya peninsula was the most southerly outpost of Mesoamerican culture (Figure 30.1a), colonized about AD 200 by peoples associated with the culture farther north, and until about 1100 their most frequent contacts were with Maya groups. At the time of the Spanish conquest, most other parts of present Costa Rica were largely uninhabited; Kent

Figure 30.3b Log hives of *Melipona beecheii* (one with a gourd end closure) outside a house in Santa Barbara, Nicoya, Costa Rica, 1991 (photo: E. Crane).

(1984b) published explanatory maps. Oviedo commented on the abundance of honey and wax in 1529, and the Spanish demanded both as tribute. By 1650 every priest who administered a native village in Nicoya was entitled to be given two *botijas* (about 110 litres) of honey a year (Kent, 1984b). Since the Spanish referred to traditional hive beekeeping in the 1500s, and Nicoya is the southern limit of the distribution of *Melipona beecheii*, it seems reasonable to suppose that hive beekeeping in Nicoya started well before 1500, as a result of Maya influence.

As recently as the 1950s, log hives of stingless bees were 'one of the most characteristic features of the rural household ... Most of the *criollo* [indigenous] households even in towns like Nicoya and Filadelfia possess their bee-logs' (Kent, 1984b). In recent years beekeepers obtained colonies by hunting for natural nests. The log containing a nest was cut off and left lying horizontally on the ground for a few days; in evening or early morning when most bees were inside, it was taken home and used as a hive. End closures were devised from gourds, wood or tin cans, and plastered in position to improve the fit. The original flight entrance was often retained, and a colony was not managed in any way except that it might be transferred to another log that was smaller, larger, or otherwise considered more suitable.

In the late 1900s beekeeping with *M. beecheii* was similar to that in Yucatan. Honey was harvested from the ends of the hive when the dry season ended, and from *Trigona (Tetragonisca) angustula* all the year round. A hive of *M. beecheii* might yield 1 to 5 bottles annually, and one of *T. (Scaptotrigona) pectoralis* or *T. (Nannotrigona) testaceicornis* less than one bottle. Honey was greatly valued as a tasty sweetener for food and as a medicine. Beeswax was used instead of fat to prime the surface of the *comal* on which *tortillas* are cooked. In areas without electricity, candles were made from beeswax (Kent, 1984b; Veen, 1991).

In 1991 I found colonies of several species kept in the logs in which they had been brought home, perhaps decades before (Figure 30.3b). On the walls of a house in Hojancha, in addition to *M. beecheii*, there were hives of three *Trigona* species: *(Tetragonisca) angustula*, *(Scaptotrigona) pectoralis*, and *(Cephalona) capitata*. But some beekeepers kept fewer hives than previously, because of the decline in bee forage and the lack of tree cavities from which they could collect bees; both factors were due largely to deforestation.

30.4 The rest of Central America and Mexico

Outside Mesoamerica, beekeeping with stingless bees was probably always less common and less integrated into local life and custom, and during the 1900s there was no single typical hive such as the horizontal log of the Maya.

North of Mesoamerica stingless bees are found in a rather small area, south of latitude 29°N. Pottery hives were used, as in Figure 30.4a or supported singly in hanging baskets (Darchen, 1973). In Son-

Figure 30.4a Lidded pottery hives near Huejutla, Hidalgo, Mexico, 1972 (Darchen, 1973).

ora, hives were gourds, earthenware jugs, or hollow logs in which wild colonies had been collected, and beekeeping was largely 'a kind of inconsequential diversion' (Bennett, 1964).

In Costa Rica south of Guatemala, bees were kept in hives in the Meseta Central, opposite and south of Nicoya (Kent, 1984b), and two species (*M. fasciata* and *T. (Tetragonisca) angustula*) in several areas still farther south (Veen, 1991).

For Panama, Schwarz (1948) quoted a reference by Thompson in 1930 to domestication of stingless bees during pre-Spanish times. Bennett (1965) described recent hive beekeeping with *Melipona favosa phenax* at the northern (inland) end of the peninsula of Azuela on the south coast. Hives were made from dried gourds (*Lagenaria* spp.) after these were discarded as water pots, and the narrow neck became the flight entrance. A 'door' about 10 cm square was cut in the most bulbous part of the gourd, and removed to harvest the honey. A beekeeper searched for a natural nest and transferred it carefully to a prepared gourd, then replaced the square door and left the hive suspended near the site of the nest for up to 5 days, during which time the bees sealed the door edges with propolis and reduced the size of the flight entrance. A good colony would yield about 2 litres of honey a year. Nordenskiöld (1929b) mentioned beekeeping by negroes in the Pearl islands.

In 1492 Columbus mentioned honey in Cuba and wax in Santo Domingo, which must have come from stingless bees (end of Section 11.3), but not necessarily in hives. The only early reference found to hive beekeeping in Caribbean islands relates to Guadeloupe in 1696 and was written by Father Labat (1722): 'I have known only one man, Louis Aligre, who has kept swarms [colonies] in *pots de raffinie* [used in sugar refining], pierced below and with a cover above.' In Trinidad, two *Melipona* species, *M. trinitatus* and *M. favosa*, were recently kept in wooden boxes (Hallim & Sommeijer, 1994).

Around 1990 several organizations started projects to rehabilitate and improve beekeeping with stingless bees in Mexico, Costa Rica, Cuba, and Mesoamerica in general (Crane, 1992).

30.5 South America

In South America the collection of honey from nests of stingless bees was highly developed among many peoples (Sections 11.4, 17.22), but hive beekeeping was only sporadic; hives were logs in which bees had nested, or domestic containers such as gourds. Nordenskiöld (1929b) believed that beekeeping was done extensively only where the native people were of a really high culture, and also that – like many other attainments – it lost its importance or disappeared when the culture was shattered by Spanish invaders. The great Inca civilization lasted from the 1100s until the Spanish conquest in the 1530s, but it was in the Andean highlands at altitudes too high for most stingless bees.

30.51 Records from the 1500s to 1700s

No archaeological evidence is known, and the earliest records were by European soldiers, rulers and travellers in the 1500s.

In 1525 Rodrigo de Bastidas founded Santa Marta on the north coast – the first Spanish town in present Colombia – and according to Oviedo (*c.* 1550) he reported in the 1540s from the land to the east, now Venezuela:

> There are many bees in the wild woods ... Indians keep some of them in their houses, in large calabashes. The bees do not sting, nor do they have any organ for stinging. They are much smaller than Spanish bees, and more hairy, and the [honey] cells of their combs – although the bees are small as I have said – are each as large as an acorn [from an oak tree].

In 1529 Pedro de Espinel wrote a letter to the King

Figure 30.5a Porch of an old colonial house in São Paulo, Brazil, with a calabash hive (see below) hung from a cross-beam, 1973 (photo: E. Crane).

of Spain (Nates-Parra, 1996); he said that natives in the Santa Marta mountains had many hives of bees round their houses, from which they got excellent light honey, mild and delicious. But the wax was dark, and the people did not know how to refine it. Simón (1626) referred to a report in the 1590s which said that there were large numbers of hives in the Valle de Caldera near Santa Marta.* There is an archaeological site at Rio de la Miel some 300 km south of the Sierra Nevada de Santa Marta, in the valley of Rio Magdelena, but I do not know the origin of the name.

To the south, Father Cobo noted in 1653 that there was no beekeeping at all in the Kingdom of Peru (Brand, 1988). Bierzychudek (1974/76) quoted a 1715 report by Francesco Salcedo y Ordóñez about the Chiapas people who lived in Paraguay and La Plata regions much farther south.

> Of bees there are considerable numbers. The Indians cultivate seven kinds. ... The most highly regarded, and also the most commonly domesticated, is the *tolondrón*. It has transparent wings, but the body is reddish yellow, with reddish hairs as well. The Chiapas of Ulúa have an enormous quantity of these bees in their dwellings, and they cultivate them with the greatest care. In a single log a little over 6 fathoms [10 m] long eleven colonies may live. These Indians thus possess great riches. From this incipient Indian apiary came the idea of establishing a whole farm devoted to bees at Olosay in the eastern part of Paraguay.

*Nordenskiöld (1929b) added in his text 'for this purpose the Indians used clay vessels'.

30.52 Records from the 1800s and 1900s

In Brazil several peoples kept stingless bees in hives (Nordenskiöld, 1929b). The Makuna in the north-west and Apapocuva in the south, took nests home from the forest and hung the logs near their dwellings (Bodenheimer, 1951, from a 1921 report). The Menimehé in Rio Yapurá made log hives, which Whiffen in 1915 said they kept in their dwellings, so 'as always to have on hand a supply of honey and wax'. According to Roquette-Pinto in 1919, the Paressí in Mato Grosso made hives out of calabashes, with a flight entrance and another opening through which honey was harvested. Nordenskiöld (1930), who quoted these details, said that the customs had a pre-Columbian origin, and he supposed that they came from Central America. Caracas peoples near the coast in north-west Venezuela also kept bees in calabash hives (Steward, 1963), and Figure 30.5a shows a recent hive in Brazil.

The people in Sabará, Minas Gerais, Brazil, divided colonies by transferring some of the brood combs from a hive into another that was empty (Saint-Hilaire, 1930). Raveret-Wattel (1875) gave a more detailed account of a similar technique in Colombia, based on one by Salzedo, according to whom the upper brood combs were transferred from the parent hive, and the queen left behind. The new hive was hung on the site of the old one (to collect bees that had been foraging), and food was put in it. In another method the brood was left in the parent hive, and some honey cells were transferred with the bees that gathered on them and the queen. The new hive was again hung where the parent hive had been, which itself was moved some distance away; after a few weeks the colony in it was large enough to be divided again.

In both Minas Gerais and Colombia, the empty hive was 'perfumed with incense' before bees were put in it. This treatment may have helped to prevent phorid flies (Phoridae) entering it. Raveret-Wattel (1875) had described damage caused to stingless bees by a tiny fly in Colombia, and in Brazil phorid flies were troublesome pests; by far the worst were species of *Pseudohypocera*, and *P. kerteszi* was identified in Yucatan. Adults do no direct harm, but females run very rapidly in and out of hives, laying many eggs, and the larvae from these can do such massive damage to bee brood, honey and pollen combs that the colony dies. When transferring all or part of a nest to a new hive, special care is necessary not to expose, even for an instant, any cells on which one of the flies could alight and lay eggs (Nogueira-Neto, 1970). The incense may have acted as a repellent.

In the western *llanos* of Venezuela – grasslands between the Apure and Arauco rivers – some peoples including the Macuna and Menimehé kept two sorts of stingless bees. The hives – either logs in which the nests were found or wooden boxes – were hung from a horizontal cross-beam at the open end of the house, 2 m from the ground. The bees were known as *guantos* and *ericas* (Steward, 1963; Rivero Oramas, 1972).

In many accounts it is impossible to know which bee is referred to, but *Trigona* (*Tetragonisca*) *angustula* was the species kept in hives by the Apapocuva-Guarani of southern Brazil, and Bertoni (1910) found that this species was 'domesticated most easily' of the many he kept in hives in Paraguay between 1890 and 1894 (Nordenskiöld, 1929b). Goudot (1846) mentioned hive beekeeping with an undescribed species of *Trigona* (*Tetragona*) in New Granada, now Colombia, and in 1922 *M. interrupta* was kept in hives along the Amazon (Schwarz, 1948).

Beekeeping with stingless bees suffered several reverses in the late 1900s. In many regions deforestation reduced bee forage and also the number of nest sites from which colonies could be obtained for beekeeping. Indiscriminate application of insecticides – especially on cocoa plantations – killed many colonies. From 1956 onwards, Africanized honey bees arrived in one area after another (Section 36.63); they became powerful competitors for the forage still available, and also took food from nests of stingless bees. It often ceased to be profitable to keep stingless bees, and Imperatriz-Fonseca (1989) quoted the following comparable figures for the honey yield 'per blooming period' in Bahia State, Brazil.

- Before the arrival of Africanized bees: 100 hives were kept in an apiary and gave 15 litres honey per hive, total 1500 litres.
- After the arrival of Africanized bees: 5 hives were kept in an apiary and gave 2-5 litres honey per hive, total 10-25 litres.

30.53 Rational beekeeping

The word rational is used here to mean 'based on reasoning', in contradistinction to traditional, 'handed down from ancestor to posterity'.

Most of the development of rational hives for stingless bees took place in Brazil, which has over 250 species. Mariano-Filho (1910) devised a hive consisting of three tiered boxes whose dimensions were suitable for *Melipona fasciata scutellaris*, and in 1931 Emelen adapted a traditional hive by adding an extra compartment above; Nogueira-Neto (1948) designed and used rational hives for a number of *Trigona* and *Melipona* species in São Paulo. He described each hive and gave instructions for harvesting honey, transferring nests into hives, and dividing hived colonies into two. Figure 30.5b shows a later improved hive on the same system for a species that builds a horizontal nest such as that in Figure 3.6a. In 1953 Nogueira-Neto wrote what has become the standard textbook on rational beekeeping with Brazilian stingless bees, and this has been substantially revised (1970; also 1997). He also (1990a) described a new horizontal hive with a central brood nest and honey and pollen pots on either side; when a colony was introduced, the pots used in the previous nest were also transferred, and the bees recycled the wax to build new ones.

Rational beekeeping was also promoted and described by Kempff Mercado (1966) in Bolivia, Rivero Oramas (1972) in Venezuela, Nates Parra (1978) in Colombia, and also in Angola (Section 30.6).

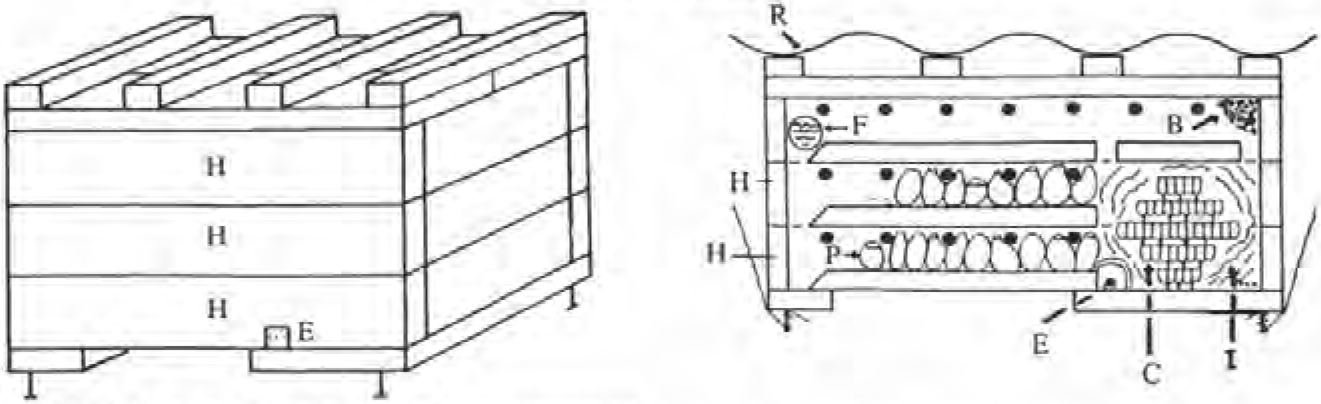


Figure 30.5b Rational hive for stingless bees, incorporating superimposed 'drawers' for honey storage (Nogueira-Neto, 1970). *left* Exterior, viewed from the side. *right* Interior, vertical section

B batumen	H honey-storage drawers
C brood combs	I involucrum
E entrance tunnel	P honey storage pots
F feeder	R roof

30.6 Asia, Africa and Australia

In tropical Asia and Africa, there are far fewer species of stingless bees than in the Americas, and their colonies mostly produce less honey than those of native honey bees. Honey was sometimes taken from natural nests, but the bees were not widely tended or kept in hives.

In tropical Asia, hive beekeeping was practised in some islands of Indonesia. Junghuhn (1857) described horizontal bamboo hives; those in the mountainous Preanger region of west Java were similar to hives for *A. cerana* described in Section 29.44, and were also called *glodok*. The bees produced 'a blackish wax containing much plant resin'; the people used it in their batik industry (Does, 1893), and when they needed more they suspended an empty hive (90-120 cm long, 15-23 cm across) horizontally under the house eaves (Figure 30.6a). Within two weeks the hive would be occupied by stingless bees 'not much larger than ants'. Such bees were described as early as 1521 (Section 10.5), and Junghuhn referred to them as *Melipona minuta* Lep. de St Farg., but Veth (1877) thought they were probably *Trigona iridipennis*. In the 1980s Vries (1988) found colonies of a *Trigona* species kept in horizontal bamboo hives in Lawang about 50 km south of Surabaya, eastern Java, and also in horizontal coconut logs in Rachgai at the southern tip of Vietnam. To harvest honey in Lawang, the bamboo was split and the honey pots squeezed; the bees shaken off might resettle in another hive. In the Sunda islands east of Java which had no *A. cerana*, stingless bees were kept in similar hives, and their honey tasted sour (Teune, 1929). In 1990 in Vietnam I heard that a *Trigona* species was kept in hives on Quan Phu Quoc, an island off the west coast.

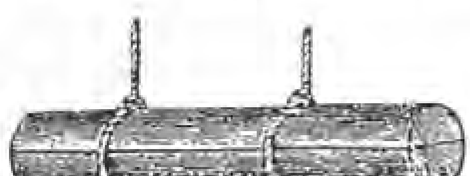


Figure 30.6a Bamboo hive for rearing a *Trigona* species in west Java, to obtain the black wax used for batik dyeing (Junghuhn, 1857).

In Sri Lanka, Seligmann and Seligmann (1911) were shown a gourd hanging outside a Vedda dwelling hut, containing a colony of stingless bees which the owner was keeping for his son, then 12 years old. It was said that in earlier days the people frequently kept hollow branches containing nests of stingless bees in their rock shelters. In Kerala, south India, stingless black bees 'the size of mosquitoes' were kept in cast-off water pots, hung nearly upright under the eaves. The bees were valued not for their honey, but for the black wax/propolis (cerumen) which was used medicinally (Morley, 1992). In the middle-altitude belt of Nepal, from Rolpa district westward, *Trigona* bees were kept in a log which was probably set horizontally or upright as it had been on the tree. Colonies of *Trigona iridipennis* were kept in rational box hives in Pune, India (Percy, 1989).

In tropical Africa there was little incentive to keep stingless bees in hives because hive beekeeping with *Apis mellifera* was widely successful. In Angola, however, efforts were made to develop the use of 'rational' hives for them in the 1950s, especially by Portugal Araújo (e.g. 1957) who based his hives on Nogueira-Neto's but made them upright. Species known to be kept in hives in Africa are included in Table 30.1A. The bees sometimes occupied empty hives for honey bees.

In the parts of Australia where stingless bees

lived, these were the Aborigines' sole and much valued source of honey and wax. But nowhere did methods of harvesting from nests advance beyond tending them (Section 17.23). In 1809/10 Samuel Marsden took to New South Wales 'two hives of bees I found in Rio de Janeiro', which I think must have been stingless bees (Section 36.81). The record does not refer to any effective beekeeping with them in either Brazil or Australia.

During the 1980s, the use of stingless bees for crop pollination was promoted in Australia, and rational hives for *Trigona* species were described by Dollin and Dollin (1985) in New South Wales, and Goebel (1986) and Heard (1988) in Queensland. The first was an upright log, and others consisted of a wooden box with another box superimposed.

31

Traditional Hive Beekeeping with Honey Bees in the Americas and Oceania

31.1 Introduction

Nowhere outside the Old World has traditional beekeeping with honey bees (*Apis mellifera*) lasted for long: the bees were introduced only from the 1600s onwards – in traditional fixed-comb upright hives – and some or all of these were replaced by movable-frame hives between 1850 and 1950. The periods when traditional hives were the only ones used in different regions were as follows.

North America	230 years	1622 to 1851
Caribbean islands	240-260 years	1617 to c. 1860s or 1880s
rest of the Americas	50 years	1830 to c. 1880
Australia/New Zealand	50 years	1822 to 1875
Pacific islands	0	

On the other hand in Mesoamerica the stingless bee *Melipona beecheii* has been kept in traditional hives for the last 2000 years (Chapter 30).

Surviving records give remarkably little information about the hives used in the new lands; many hives were probably logs in which bees had nested, or else some sort of wooden box, since sawn timber would have been available by the 1600s. Most settlers who introduced honey bees were from parts of Europe where hives were upright, so this became the norm in most of the New World. Bee management was more primitive than methods practised several thousand years earlier in the Ancient Mediterranean world. But in early years the number of colonies – and the human population – was very small, and the introduced bees often did extraordinarily well and spread rapidly (Section 36.2).

The earliest known record of beekeeping with honey bees outside the Old World was written in Bermuda on 25 May 1617: 'The bees that you sent doe prosper very well. They stand as yett in the Governors garden but I am purposed towards michellmace [Michaelmas, 29 September] to remove them when I have builded a convenit place for them.' Section 36.21 explains how these bees reached Bermuda.

31.2 USA and Canada

31.21 Early records: the colonial period, 1622-1783

Section 36.22 describes early introductions of honey bees to mainland North America (the first in Virginia in 1622), and the bees' spread to different regions. In New England farther north honey bees were said to 'thrive exceedingly' in 1638 (Oertel, 1976a). Many woodlands in North America then contained mature trees with large cavities in which bees could nest, and honey hunting was common (Section 12.2). There was probably soon an abundance of nests in relation to the human population, and ownership of them does not seem to have been important. But swarms, and bees from the nests, were collected to put in hives.

Most records of the existence of hive beekeeping in the 1600s are from Massachusetts where the first English settlement was established in 1620. Like most others quoted below, they show that beekeeping existed, but little more. In 1640 a town apiary was established in Danvers, Essex County. Nathaniel Tilden, Elder at Scituate, had emigrated to Plymouth Colony from Kent in England before 1628, and when he died in 1641 he left 'ten stocks or swarms of bees, appraised at 10 pounds' (Witherell, 1976). In 1644 J. Eales went from Hingham to Newbury to make hives and instruct citizens in beekeeping, and in 1645 he was subsidized by 'ye Towne of Newbury' to follow 'his trade of beehive making'. In 1660 a stand of bees at Danvers was appraised at £5, and in 1661 E. Rogers, formerly of Rowley, had a 'stak of bees valued at £3'. In 1665, a mother bequeathed a skep of bees to two daughters, and they were desired to give the first swarms from them to their two other sisters. An inventory of T. Barnard's estate, made after he was killed by Indians in 1677, included eight hives of bees (Adams, 1906, 1921).

Stocks of bees were also mentioned in probate lists made between 1644 and 1648 in neighbouring Connecticut and the New England Federation (Oertel,

1976b). In Virginia farther south Mr George Pelton 'had a store of colonies' in 1648 which gave a profit of £30 a year; by then honey and beeswax were common (Oertel, 1945). In 1651 Samuel Hartlib reported that 'bees thrive very much in New England'. Bees were flourishing in New York state by 1670: 'You shall scarce see a house, but the South side is begirt with Hives of Bees, which increase after an incredible manner' (Bidwell, 1925).

Farther south still, in the Albemarle region of North Carolina, 'a plank that Mr Hawkins sent over to sett hives of bees upon' was mentioned in 1697 (Ambrose, 1990). Wills and inventories made between 1730 and 1774 included stocks of bees, hives and beeswax (Oertel, 1976c). There are records about beekeeping in other south-eastern states from the 1700s. In Georgia, Mr Anderson gave Mrs Causton two hives for her experimental garden in 1737, and Mr Walker had 80 hives on St Simon's Island in 1743. In 1770, settlers had started coming to Tennessee in fairly large numbers, and 'from their first settling, many farmers secured a few colonies of bees' (Oertel, 1976d). Between 1770 and 1775, hives were common in the Natchez district of Mississippi, and some hives were taken from Florida to Cuba in 1764 (Brand, 1988), so they must have been used in Florida by then. In 1768 Stephanus Hunt in West Chester County, NY, had 'the greatest number of bee hives kept over last season, 22' (Krochmal & Krochmal, 1991).

In 1776, a Declaration of Independence was made in Philadelphia, and the consequent War of Independence (from Britain) lasted until 1783 when the United States of America was recognized. A British Army Officer who served during this 'Revolution' commented that, whereas in Pennsylvania 'almost every farmhouse has 7 or 8 hives of bees, in New England [there are] very few' (Woodward, 1952). From 1775 the general direction of the war effort on behalf of the thirteen American colonies was assumed by the Continental Congress. One of the first banknotes of the United States of North America which the Congress issued between 1775 and 1779 included a drawing of two coiled-straw skeps in an open-fronted shelter (Figure 31.2a). Krochmal and Krochmal (1991) showed a skep on a Masonic document engraved in 1772 in Newburyport, MA. Less realistic skeps were used on later banknotes issued in various states; Wyatt Mangum found examples issued between 1837 (25 cents) and the 1860s (75 cents to \$20).

The first record found of hive beekeeping in the region which later became Canada was in 1776 (Section 31.23).

Figure 31.2a Forty-five dollar bill issued by the Republican Congress in Philadelphia in 1779 (photo: National Museum of American History).

Figure 31.2b Straw skeps at Mount Vernon, Virginia, 1953 (photo: E. Crane). Colonies of bees in Langstroth hives below provided the flying bees.

31.22 Early records: USA 1783-1820

In 1787 George Washington, then President, had a 'bee house' built in the grounds of Mount Vernon which he had inherited. In 1953 a replica was in place with three straw skeps (Figure 31.2b).

Pioneers had taken bees to Kentucky in the 1760s, and hives were mentioned there in 1780. Especially in southern states, many log hives were made from black gum (*Nyssa sylvatica*), because its heartwood decays first, leaving the trunk hollow. Such hives were called gums, and this word came into general use for any hive. Gums were mentioned twice in Georgia in the mid-1780s: Harrod 'got a bee gum' which was taken down river in a canoe, and Governor Selby 'gave a cow and a calf for a gum' (Oertel, 1976a, 1976d). Figure 31.2c shows a row of bee gums, and Figure 31.2d a cottonwood 'gum' in Canada.

In Vermont in 1794 bees lived in 'our artificial bee hives' as well as in hollow trees (Oertel, 1976b). There are few records of the participation of native Americans in beekeeping, but in 1796 some in north Georgia had hives and were trading in honey and beeswax. In the same year Mr Bailey had twenty hives near Coosa River in Alabama (Oertel, 1976c).

A number of books on traditional beekeeping were published in North America between 1790 and 1820.

1792 [Thomas, I.] *A complete guide for the management of bees, through the year* by a Farmer of Massachussets (Worcester, MA: author) 46 pp. Text from D. Wildman (1773, London).

Figure 31.2c Upright log hives of black gum (*Nyssa sylvatica*), North Carolina, 1958 (photo: W.A. Stephen).

1803 *A short history of bees* (Philadelphia: Johnson) Copy of a book published in London (1800).
1804 Miner, T. *The experienced bee-keeper* ... (Litchfield, CT: T. Collier) 21 pp.
1813 Doddridge, J. *A treatise on the culture of bee* (Ohio) 32 pp.
1819 Butler, F. *The farmer's manual ... with a treatise on the management of bees* (Hertford, CT: S.G. Goodrich); 76 of the 224 pp. are on bees
1819 Wiestling, J.S. *Die vollstandige Bienen-Wörter, oder nützliche Anweisungen zur Bienen-Zucht* (Harrisberg, PA: author) 50 pp.

31.23 Early records: Canada before 1850

Table 36.2B includes a list of the earliest dates found for the presence of honey bees in Canadian provinces – from 1776 in Ontario, and 1790 in Quebec which had become a French colony in 1608. King (1983) could find no evidence that French settlers kept bees, and historians seem to agree that beekeeping was unlikely to have been started under French rule, i.e. before 1763. The probate entry for Jean Madry dated 30 July 1669 in *Archives rationales du Québec à Québec* apparently listed *une ruche* (a hive) in the bakery (Desloges, 1995). But the handwritten word could be *une huche* (a kneading trough, or bin for flour or bread) instead of *une ruche*, and this would be more appropriate for a bakery (Reid, 1995; Forget, 1996).

Very little has been known about the earliest beekeeping in Canada, but several Canadians have now sought references and found those cited below.

Pehr Kalm was told in 1749 that bees had been taken to Canada, presumably to Quebec, but 'always died in winter' (Oertel, 1976b). The Ursuline Convent in Quebec has detailed records of its imports of beeswax from France up to 1758, whereas in 1812 five barrels of beeswax were exported from Quebec (*Montreal Gazette*, 19 January 1813). This suggests that Quebec province had little or no beekeeping before 1758. I think it likely that there were no honey bees in Canada until the 1770s, and the five earliest references found to beekeeping are in 1776, 1790, 1793, 1793 and 1797.

(*a*) In an obituary of Bryan O. Lott, the *Canadian Bee Journal* (1947) recorded him as saying 'that his great-grandfather arrived from Scotland in Hastings county [Upper Canada, now Ontario] in the year 1776, bringing with him six skeps of bees'. The writer added: 'It is unfortunate that the family records do not show how many skeps started the long trek from Scotland.'

(*b*) From 1783 when the American War of Independence ended, 60,000 United Empire Loyalists left the new United States of America and moved north to settle in what is now Canada, mainly in Ontario, Quebec and Maritime provinces. Some took their bees with them (Haight, 1885; King, 1983), and the fact that at least one Loyalist kept bees when he went to Quebec in 1790 was confirmed by his great-grandson (Turcotte, 1982).

(*c*) In 1792, a Moravian missionary settlement of Delaware Indians was established in Fairfield (east of Detroit, now in Kent County, Ontario). In his diary for 27 June 1793, Brother David Zeisberger from Moravia mentioned two hives of bees brought there from a Moravian Mission in Ohio by Indian Peter (Chief Echpalawchund): they 'swarmed today for the second time. There are none here in the bush in the whole neighborhood' (Reaman, 1957). Gray and Gray (1956) gave further details of this beekeeping. Rye straw, used in Pennsylvania for making hives, was in short supply, and 'spiral rye twists were meshed with hickory to make hives'. However, in 1811 when 17 swarms issued from the 23 hives the Mission then had, extra hives were hastily made from lake rushes woven into mats. In 1813, during the war between the USA and the British in Canada, US troops looted and burned Fairfield, and a diary entry for 5 October reads: 'A very hard and oppressive day for us. ... Ten beehives, most of them well filled, were also emptied and eaten up. The honey was eaten out of the combs without killing the bees. For this reason the soldiers while enjoying the honey were surrounded by swarms of bees.' Among the items 'taken possession of' were ten well stocked bee hives valued at $50.

(*d*) Patrick Campbell's important account of his travels (1793) gave a little information about beekeeping at that time and included a method for locating a bees' nest (Section 12.22).

(*e*) On 29 March 1797 the *Upper Canada Gazette* gave Ontario farmers 'explicit instructions on keeping of bees', taken from the *Boston Register* (Errington, 1987). On 31 August 1799 it advertised 'Honey for sale by the pound in large quantity'.

King (1996) cited the following two items from the early 1800s. In 1801 'one hive of bees' was among goods and chattels of a bankrupt man in Niagara. In 1806 in Quebec City region: 'Bees are plentiful ... and a few of the Canadians keep honeybees.' In the same year 899 pounds of honey were imported into Quebec through St John's (Gray, 1809). In Ontario, the *Kingston Gazette* for 23 October 1810 reported that 'the total destruction of the bees in the fourth part of our

country is apprehended'; this destruction was caused by the greater wax moth (Section 38.4).

Bees were referred to again during the war between the USA and the British in Canada, and King (1983) located the following record in the Public Archives of Canada. In November 1812 Samuel Lewis at Burtonville, south of Montreal, submitted a claim to the British Army for property destroyed by His Majesty's Troops (Canadian Voltiguere and Indians); it listed '4 hives of bees £6', other animals and food stores, etc., and '1 schoolhouse burnt £15, my house burnt £25'. Jonathan Sawyer submitted a similar list that included '1 hive of honeybees 25s. [£1.25]'. The British Government paid the claims. King commented that since these were made in November, the bees were being overwintered.

Losee's 1885 account of his memories of beekeeping in Ontario said that 'as early as 1830 bees were plentiful, both wild and in a domesticated state, and managed successfully by the inhabitants'. In 1830, 'a great calamity came upon the bees in Prince Edward Island, where three of my uncles on the banks of East Lake had kept bees in sheds made for the purpose, two of them lost all their bees, leaving their bee houses and hives empty; they never returned to beekeeping again, not knowing the cause of the great loss that befell them. In time bees became more plentiful ... and were kept on long open stands in board hives with success.'

Bees were not taken west of Ontario until after movable-frame hives were in use, and what is known of the beekeeping history of western Canada is included in Section 41.2. Beekeepers in British Columbia put swarms in log hives and used them to build up their modern apiaries. Figure 31.2d shows a pioneer trapper with his hive made from a straight cottonwood trunk.

Figure 31.2d Joe Murray, pioneer trapper and fur farmer (photo: W.H. Turnbull). He is seen here with one of his 'gums' of cottonwood (*Populus*), north-central BC, Canada.

31.24 Later records, and how traditional hive beekeeping was done

The list in Table 36.2B shows that most states in east and central USA had honey bees before 1850. (The bees were introduced in movable-frame hives to many of the remaining states, so traditional beekeeping may have hardly existed.) Langstroth started beekeeping by purchasing a pine box of bees for $8, and in 1835 he bought Dr Jerome van Crowninshield Smith's 1831 book, which he described as 'my first book on bees' (Fraser, 1951a).

In the 1830s New York state was regarded as a 'beekeeper's paradise'. In 1841 there were 'dozens of hives on every farm' in east Mississippi (Oertel, 1945, 1976e). In the same year T. Affleck in Ohio published

Bee breeding in the west. Bees were very important to the Mormons, who first arrived in Utah in 1847 and soon took bees there; in 1851 Brigham Young said that 'several hives were responding well to conditions in Utah'. The Mormons probably used straw skeps, or at least knew them, since the Great Seal of Utah featured a notional one.

Some of the other hives referred to in records would also have been coiled-straw skeps, but Oertel (1980) believed that skeps were very little used in North America, and I share this view. Their sporadic use could have been maintained by new immigrants from parts of Europe where skeps were still the norm. In 1953 I saw one in use near Wallingford, CT, which came from a very old beekeeper at Hoosie Falls, NY.

Most beekeepers had access to an abundance of timber, and also metal cutting tools. Hives made of logs already containing a bees' nest when they were cut from the tree probably greatly outnumbered the

labour-intensive and less durable skeps. As and when wide planks of wood became available, they were used to make box hives, which were initially tall like the logs. The number of hives owned by one beekeeper tended to increase as time went on, but Section 31.21 refers to one man with 80 hives in Georgia in 1743.

In 1850, when there were not yet any honey bees on the west coast, New York state, Missouri and Kentucky each produced more than 500 tonnes of honey, and Tennessee slightly less; Indiana and Alabama came next (Oertel, 1976d). But in the same year New York state produced nearly 5000 tonnes of maple syrup – more than any other state.

Before movable-frame hives were described (Section 40.7), one of the best beekeeping books published in the USA was by Miner (1849), who wrote separately about winter management in 1851. After movable-frame hives arrived, fixed-comb hives were less used, and they were later prohibited by law in individual states and provinces, because of the impossibility of examining the bees and combs for signs of disease. But their use continued sporadically, especially in poorer and more remote areas, and in a few places within living memory. J.E. Crane (1931) described beekeeping in Vermont between 1850 and 1879.

> Hives for the most part were made of boards of uneven widths, or straw, or sometimes of a section of a hollow log. The size or capacity of these hives varied from a half bushel to two bushels or more [15-60 litres; a 10-frame Langstroth brood box holds 40 litres].
>
> Every one so far as I remember had a bee-house – an open shed 12 or 15 feet long by 4 or 5 feet wide, open on the south side and boarded up on the north side and also the ends [1 foot = 0.3 m]. There were two shelves, one near the ground and the other about 3 feet above on which the hives were set. Sometimes, setting up at one end of the house, there was the section of the trunk of a tree 6 or 8 feet long that had been brought in from the woods with a runaway swarm in it. ... For the most part, honey was taken in the fall by killing the bees with sulphur fumes. The best combs were cut out for the table and the dark combs were put through a strainer by the good housewife.

The killing of bees with sulphur (brimstone) before taking their honey was in keeping with the treatment of other livestock at the end of summer: only breeding stock could be kept over winter, and other animals were killed to provide food for the family.

31.3 Mexico, Central America and Caribbean islands

31.31 The mainland

In this region we know very much less about early beekeeping with honey bees in traditional hives than about beekeeping with stingless bees (Sections 30.2, 30.3). It is not even clear whether the first European honey bees reached Mexico in the 1500s, 1600s or 1700s (Section 36.22, g). If the bees were introduced early, beekeeping with them subsequently declined – possibly for reasons suggested by Stoll (1887), Zozaya (1968) or Brand (1970). But any introductions before the late 1700s were probably only to central Mexico (Molina-Pardo, 1989). Beekeeping with fixed-comb hives was certainly developed after Mexico became independent in 1821, but Yucatan was without honey bees until the late 1800s, when movable-frame hives were available.

Whereas British and French settlers seem to have done what they could to establish beekeeping with honey bees (Section 36.2), there are few reports of the Spanish doing so in this region, and these are vague and second-hand. The Spanish were believed to have kept honey bees around Old Léon (Banco Nacional de Nicaragua, 1976), but no confirmation of this was found (Kvarnbäck & Svensson, 1985).

The earliest record in Table 36.2A for Central America is from 1830 when honey bees were taken from Costa Rica to Guatemala, presumably in hives (Stoll, 1887). In 1849 Rafael Barrveta presented a Bill to the Agricultural Commission of Costa Rica for promoting the husbandry of silkworms and honey bees (Kvarnback & Svensson, 1985). Early beekeepers used logs and simple boxes as hives in Guatemala, and probably elsewhere.

In the 1900s horizontal hives were used in some places, for instance in Tamaulipas state on the east coast of Mexico, where they were made from logs of softwood trees, baskets, pottery or wooden fruit crates (Reséndez *et al.*, 1988). End closures of a log hive were carved wooden plates, one containing the flight entrance. The hives were raised above the ground and protected from rain; Figure 31.3a shows box hives in Morelos state similarly raised and protected.

In 1979 Kent found that fixed-comb hives in Central America represented the following percentages of the total number:

Figure 31.3a Horizontal box hives near Quautla, Morelos state, Mexico, 1957 (photo: E. Crane).

Honduras	25-75%	Guatemala	3-25%
El Salvador	44%	Belize	a few
Costa Rica	15%	Panama	0

31.32 Caribbean and neighbouring islands

Table 36.2C gives the first recorded dates of arrival of honey bees in some of the islands, which the first Europeans called the West Indies.

The first known record of hive beekeeping in the New World (Sections 31.1, 36.21) was written in Bermuda in 1617, north-east of the Caribbean. The bees presumably continued to prosper, because in 1622 Bermuda exported small amounts of honey and beeswax to the West Indies, and sometimes to American colonies (Kevan, 1981; Hilburn, 1989). Barbados, which like Bermuda had been colonized by the British, was less fortunate: Purchas's 1657 book reported that European bees were not successful there, as they were all eaten by certain birds – probably a kingbird (*Tyrannus* sp.)

Beekeeping started next in islands of the Lesser Antilles, possibly in 1688/89 (Section 36.24). Hives of honey bees must have been in St Kitts before 1720. Nevis, next to St Kitts, still had box hives in 1986, but movable-frame hives were established by 1988.

From the 1700s there are records from the Greater Antilles – Cuba, Hispaniola, Puerto Rico and Jamaica – and the nearby Cayman Islands. Cuba was without honey bees until the 1760s (Section 36.24), but beekeeping started to develop from 1772. In Cuba beeswax was a more important commodity than honey, and was exported from 1770 onwards in increasing annual amounts (Diaz Millan, 1985):

1774	37 tonnes
1803	582 tonnes
1800-1830	950 tonnes, also 1146 tonnes of honey.

'The wax of Cuba comes only in a small part from "Trigones" that live in the trunks of *Cedrela odorata*; most is from the north European bee whose cultivation has become extended since 1772' (Humboldt, 1811). 'This wax is not the product of the indigenous bee (*Melipona* of Latreille), but of bees introduced from Europe by way of Florida' (Gerstäcker, 1862).

In 1789 the use of cedar wood for hives for honey bees had been prohibited in Cuba, as being too valuable. In 1796 there were 1500 hives in Matanzas alone, and in 1797 Don Eugenio de la Plaza published a 51-page book in Havana, on beekeeping and wax production (Walker, 1929). By 1902 Cuba had more than 82,000 hives, 80% of them logs or others with fixed combs (Diaz Millan, 1985).

In 1781, M. le Comte de la Croix, Captain of the *Annabel*, had transported six hives of bees from Martinique to his home in Hispaniola, the island now divided between the Dominican Republic and Haiti. Most colonies perished after landing, and the rest 'took refuge in the neighbouring mountains. But some of the inhabitants ... captured young swarms, which prosper' (Gerstäcker, 1862). In 1978 the Dominican Republic had 100,000 log hives, as well as 50,000 with movable frames (Santana Pion, 1978). Mulzac (1989) found both horizontal and upright log hives there and in Haiti, which also had box hives.

The only reference found to beekeeping with fixed-comb hives in Jamaica was by Gilpin (1886), a visiting Canadian who saw bees kept by 'blacks'. In one apiary, 'hives consisted of soap boxes turned upside down and resting on four stones, one at each corner, to raise the hive 4 or 5 inches above the ground'. The bottom of the hive was open, and combs sometimes hung below, almost touching the ground. To harvest honey, the beekeeper smoked the bees and shook them on to the ground, then put an empty box over them. 'The people are beginning to use frame hives, but most prefer the box hives.' Red ants were a great pest, and some hives were fixed about 4 ft high, on legs standing in pans of water. Frogs and birds destroyed many bees, and in times of drought a great many drowned in molasses troughs.

In the Caribbean area, European bees were thus kept in fixed-comb hives for over 200 years before movable-frame hives were used. Contemporary records tell us rather little about the hives or beekeeping methods, but the high honey yields obtained later from movable-frame hives in some

islands (Section 41.42) suggest that earlier beekeeping was also productive.

31.4 South America

Most of South America except part of Brazil was taken by the Spanish in the 1500s. As elsewhere, the Spanish were not active in introducing European bees or in developing beekeeping, and native peoples continued to collect honey and wax from nests of stingless bees. Nogueira-Neto (1967) showed that European honey bees first reached Brazil in 1839 (it had become an independent kingdom in 1822), when Father Antonio Carneiro succeeded in getting 7 out of 100 colonies from Portugal to Rio de Janeiro (Section 36.25). He established the bees in an apiary at Praia Formosa, and by the end of the year he had increased them to 50 colonies. Within two years there were 200 or more, and this success encouraged many people to take up beekeeping. According to Branco in 1859 there were 300,000 colonies in Brazil, all descended from the 1839 importation. In 1845 German immigrants had taken some of the bees to Rio Grande do Sul and Santa Catarina in the south of Brazil.

Nogueira-Neto (1967) detailed what was known about early records of honey bees in other countries and regions of South America; see also Section 36.25. Photographs from the Santander region of Colombia published by Serre (1980) show open-fronted shelters with three shelves supporting horizontal box hives with open front ends, and combs built along the length of the hives. Beekeeping with fixed-comb hives must have been widely practised, and it lasted well into the 1900s in some parts, but we know very little about methods used. In Peru in the early 1980s (Kent, 1986) 60% of hives on the coastal plain had fixed combs, whereas all hives in the *selva alta*, high jungle on the Andes watershed, were fitted with movable frames. Section 41.43 gives percentages of movable-frame hives during the 1900s in some other countries.

Most hive beekeeping was probably done by settlers of European descent, but Section 12.4 refers to one native people, the Apapocuva in Paraguay and south Brazil, who 'acclimatize swarms of bees to their villages'.

31.5 Oceania

Sections 36.31 and 36.32 give details of the first transport of European honey bees to this most distant region. Weatherhead (1986) suggested that in Australia beekeeping was at first 'the pursuit of the landed gentry or, in Australia's case, the land holders and squatters. In 1831 bees and 200 convicts sailed from London to Hobart (p. 364). Britain maintained penal settlements in Australia until about 1838, and the ship that brought the first honey bees to the Australian mainland in 1822 transported convict no. 680 from Gloucester in 1829 – to undergo a sentence of seven years for stealing honey (Rayment, 1922). The first bees were kept at Parramatta in New South Wales, and in 1823 the Sydney *Gazette* reported their success (Weatherhead, 1986). In 1839 John Hughes succeeded in taking bees alive over the Blue Mountains, and in the same year a settler from Jarvis Bay who purchased two colonies for £4 'engaged two Aborigines to carry the hives on their heads a distance of 40 miles. These were the black or English bees. ... A swarm was put into a hollow log, sawn off evenly at both ends, with pieces of stringy bark wood nailed over the openings. Tea chests or boxes of other descriptions were preferred, but not always available' (Mocatta, 1962/63). On 12 May 1845 the *South Australian* published an article 'Management of bees in New South Wales' by T.H.S. of Brisbane Water, who was given his first hive in 1842 and had got prodigious honey yields (Barrett, 1996). His hives were a larger version of Bevan's (1827) described in Section 40.3. Honey was exported from New South Wales in 1845 (Barrett, 1995).

In Queensland, W.F. Lyon saw bees arrive on the second immigrant ship to Moreton Bay, in 1857. Writing in 1919, Lyon's memory of beekeeping around 1863 was that the standard box hive was a gin case – in which bottles of gin were transported from England – and that he was presented with a swarm in a tea chest by a timber cutter who had taken it. In 1869 'nearly every farmer in the district had a dozen or two hives. ... I used to go around the neighbouring farmers and take their honey for them ... in those days there were no frames or extractors; combs were broken up and placed in bags to drain out. ... Honey was sold at 1d. [0.4p] per lb and beeswax at 6d. [2.5p].' In 1922, on Stradbrooke Island 'both native and white fishermen' felled trees to get honey, and 'sometimes took the bees also, to put in boxes'. So perhaps some Aborigines kept honey bees in hives, but I have found no direct information on this.

Almost nothing was found about hive beekeeping in other states before movable-frame hives were used in the 1870s. A hive with 'four compartments communicating with each other', probably similar to Nutt's (Section 40.4), was described in the *South Australian* for 8 September 1846, and Jacob Pitman

of Adelaide made one for 'a gentleman in the country'. By 1846 honey bees were also in Western Australia (Coleman, 1956), and by 1862 they were in Victoria which had been part of New South Wales until 1851.

In New Zealand, hives of European bees reached North Island in 1839 and South Island in 1842 (Section 36.32). Most settlers kept bees in common boxes or gin cases fitted with cross-sticks to support the combs, and a few made straw skeps. (Most of the Maori to whom W.C. Cotton taught beekeeping in the 1840s used skeps; Stevenson & Barrett, 1997.) Bees were killed to harvest the honey, which was extracted from combs by the cruder methods described in Section 46.1 (Winter, 1954). During the 1880s many colonies became infected with American foul brood disease, which went undetected in the fixed-comb box hives since brood combs could not be inspected; box hives were finally proscribed in 1906 (Section 41.52). Colenso (1895) recorded that James Busby in Waitangi gave him a hive of bees before 1844, which he took to Hawkes Bay. Busby then had 'old-fashioned box hives', and also one with a 'glass vase, or room, fixed on top, and bees made honey there'. This was probably a bell jar such as those shown in Figure 38.3e.

W.C. Cotton's *Manual for New Zealand beekeepers*, published in 1848, was probably the only book on fixed-comb beekeeping in Australasia, except that Cotton also published *Ko nga pi* (Treatise on bees) in Maori in 1849. Beekeeping was taught to the Maori by missionaries.

By the time honey bees were taken to Pacific islands (Section 36.33) movable-frames were in use. However, some beekeepers used fixed-comb hives; for instance in 1922 in New Caledonia Italian bees were kept in petrol cans provided with entrance holes. In Easter Island 'rustic hives' were used, probably from 1930, but no bees were left in them by 1981 (Velasco, 1989); it is likely that deforestation had destroyed the bee forage.

32

History of Apiaries

32.1 Characteristics of apiaries

32.11 Requirements

In this book the term *apiary** is used for the place where bees were kept, usually in hives; a number of colonies were thus concentrated in a small area whereas, in nature, nests of individual colonies were well scattered. In most apiaries the bees were in hives, and the following requirements had to be attended to.

- Security of the hives and their contents from damage by animals, and from human theft or interference.
- Convenience of the site for the beekeeper to get access to the hives and to watch for swarms.
- Shelter from excessive heat, or from cold winds, and sometimes also from rain.
- Presence of plants within the bees' flight range to provide good forage for as much of the year as possible.
- Absence of other apiaries so close that there was detrimental competition for forage.
- Proximity to a suitable water supply, or the possibility of providing water within the apiary; in hot dry climates this might be a critical factor.

Some of the requirements were enforced by law from early times, for instance to prevent undue competition for forage between bees from neighbouring apiaries, to prevent livestock damaging bees or hives, and to ensure that bees would not sting people or livestock. As early as 594 BC, Solon passed a law in Athens prohibiting the placing of hives within 100 m of those belonging to someone else. According to a Danish law of 1683 (5.13.1-3), an owner of bees had to fence them against other people's animals. If the fence was inadequate, he got no compensation if animals entered and knocked the hives down, and he had to pay compensation if cattle got inside and were stung to death. A 1793 Danish regulation stated that hives might not be placed closer to a road than 6.5 m (Andersen, 1934). In recent centuries at least 24 countries – 11 of them in Europe – passed laws on the placing of hives, some banning them altogether in built-up areas (Crane, 1990a). Examples of laws relating to the theft of hives are given in other Chapters.

*The word, derived from Latin *apiarium* (e.g. Columella IX.5.1), was first used in England in the 1650s by Evelyn, and by Hartlib and those who corresponded with him (Section 40.2). Italian and Spanish use *apiario*.

32.12 The Ancient World and its legacy

Roman writings about apiaries (Chapter 24) had a great influence on subsequent practice in much of Europe. Varro wrote: 'So far as the situation [of the apiary] is concerned, one should preferably be chosen close to the villa – and some people place the apiary actually in the portico of the villa, so that it may be better protected.' Hives should be placed 'where the air is temperate, not too hot in summer, and not without sun in winter; they preferably face the winter sunrise, and have near by a place which has a good supply of food and clear water. If there is no natural food, the owner should sow crops which are most attractive to bees' (III.16.12-13). Varro also listed many suitable crops, and Columella added other details.

From Roman times onwards beekeepers were anxious to do the best they could for their bees, and they attended to features of the apiary that were within their power to alter. For instance great attention was paid to the direction in which hives faced; Columella made two comments: 'A position must be chosen for the bees facing the sun at midday in winter' (IX.5.1), also 'The bees' dwelling-places ... ought to be so arranged as to face the south-east, in order that the bees may enjoy the sun when they go out in the morning and may be more wide-awake; for cold begets sloth' (IX.7.5). The first of these instructions was followed until recent times in much of Europe farther north. For example in England Tusser said in 1557 that 'hives should be set south, good and warme', and Southerne (1593): 'turn the [entrance] hole towards the South ... for the South wind never bloweth so cold

as ye other winds, and therefore is more kinder for them [the bees].'

The recommendation to site hives where they would be under constant surveillance was handed down through many centuries. In England Butler wrote in 1609:

> For your bee-garden first choose some plot nigh your home, that the Bees may be in sight & hearing, because of swarming, fighting, or other sodaine happe, wherein they may need your presente helpe ... See that it be safe, and surely fenced, not onlie from cattaile ... but also from the violence of the windes, that when the Bees come laden and weary home, they may settle quietlie.

In north-western Europe, where swarm beekeeping was practised (Section 27.11), it was especially important to keep a watch on hives when the bees might swarm. Contemporary illustrations of some European apiaries from the 1500s onwards appear in this Chapter; see also Armbruster (1938a).

32.13 Types of apiary

In regions where there was a great difference between day and night temperatures, hives were often sited where these fluctuations would be reduced: in a wall or a large stack which provided thermal insulation, or in a tree high above the ground.

Section 4.5 mentioned several features of honey bees which could be detrimental if colonies were placed in close proximity. Bees could move between neighbouring hives by drifting or robbing, and in so doing they could transmit diseases and parasites from one colony to another. Also, the beekeeper was more likely to be stung if an apiary contained many hives. In 1796 Keys in Britain argued strongly against placing hives close together, especially in a shelter.

> It is very *wrong* to place *hives* on benches, which is always the source of mistakes, quarrels, and often slaughter, by their interference with one another. A still worse contrivance is that of little *cots*, or sheds, with shelves therein, one above another; affording a greater harbour for their enemies, very inconvenient for the management ...

The number of hives in an apiary varied according to the beekeeper's circumstances and the richness of the bee forage in the area, and also the local bees and local custom; in Egypt apiaries were exceptionally large. Many people probably kept only a few hives, to supply the family with honey and wax. Some kept up to 30 or more as a sideline occupation. Beekeepers who made their living from beekeeping usually operated in areas that gave good honey yields, and were likely to keep up to a hundred hives or, usually in more than one apiary, a thousand or more. Whatever the status of the beekeeper, the maximum number of hives that could profitably be kept in one apiary depended on the amount of bee forage during the year within the bees' flight range, say 2 km.

Migratory apiaries, where hives were taken for a particularly prolific honey flow, are discussed in Section 35.3; they might contain many hives if the plants producing the flow covered a wide area. Also, many beekeepers might set up apiaries close together; for instance there were up to 100,000 hives near Mugla in Turkey, and 10,000 on the island of Thasos in Greece.

It was common for colonies of tropical honey bees (*Apis mellifera* in Africa and *A. cerana* in Asia) to abscond from their hives seasonally. However many or few hives were in the apiary, a large proportion were then left empty, and the beekeeper cleaned them and prepared them for reoccupation by incoming swarms when the next flowering season was due.

32.2 Hives in, or on the side of, a wall

32.21 Horizontal hives housed within a wall

Hives embedded in a wall were usually placed across its thickness. The wall might be free-standing, but was often the outside wall of a building, in which case the flight entrance was at the outside end and harvesting was done inside the building. Such hives were quite well protected against extremes of temperature, and against damage by animals.

Section 21.1 refers to a discussion in the Babylonian *Talmud* (*Ukzin* 3.11), compiled about AD 500, as to whether a hive counted as immovable property: this suggests that some hives were embedded or otherwise fixed in place. Bevan (1827) had heard that in Persia 'the hives are thrust horizontally through the walls of dwellings, with the circular door, luted [cemented] and placed next the interior, an outlet for the bees being formed at the opposite end. The hives project more than a foot [30 cm] into the room, and when the honey is taken, the projecting ends being well drummed for a few minutes, causes the bees to withdraw to the other.' In the 1990s hives were kept on shelves in the thickness of a wall or embedded in

Figure 32.2a Pottery hives embedded in two bee walls that formed part of a bee house, near Bargota in the Ebro valley, Spain, 1961 (photo: E. Crane). On the right, hives are empty and the ends removed; on the left, the ends are still in place.

it in south Fars province, Luristan and Azerbaijan; in some other provinces hives stood against a wall or in the wall of a dwelling house (Mossadegh, 1993).

Embedded hives recorded recently were often of coarse pottery, for instance in Spain (Figure 32.2a, reported in 1956 by Erup), parts of Greece, Central Anatolia (Erdbrink, 1970), and northern India. Others were of mud, as in Cyprus (Figure 22.1a), or made by hollowing out a log or wooden beam and embedding it either along or through a house wall, as in Afghanistan (Section 29.5).

The substantially built wall of a dwelling house was used in various other ways to support and protect horizontal hives. In the upper Indus basin (Section 29.5) round Srinagar in Kashmir, hives of *Apis cerana* were stood on shelves built within the thickness of the outside house wall; in Swat in Pakistan they were placed in the wall or against the inner side of it (Figures 32.2b and 32.2c). A flight entrance

Figure 32.2b Flight entrances (ringed in white) to hives of *Apis cerana* embedded in a house wall in Miandam in Swat, upper Indus basin, Pakistan, 1993 (photo: E. Crane).

Figure 32.2c Another part of the cluster of houses in Figure 32.2b (photo: E. Crane). There are four hive entrances in the wall of a house built on one level. In the foreground a single hive (belonging to a house on a lower level) rests on cross-sticks.

was made to the outside, and honey combs were removed and any other operations done inside the house.

32.22 Hives on the outside of the wall of a building

In many parts of the world, a few traditional hives were often kept round the outside of a house where they were sheltered and protected.

Horizontal cylindrical hives of *Apis cerana* were commonly hung on the wall of a single-storey dwelling house or outhouse, for instance in Nepal, north Vietnam, China and Japan (Figures 29.2a, 29.3c), and Bali in Indonesia (Figure 32.2d). So were logs containing colonies of stingless bees in certain parts of Mesoamerica (Figure 30.3b). Figure 30.4a shows lidded pottery hives on shelves.

Although colonies of *A. mellifera* were larger and more likely to sting, they were also sometimes kept round the house; in parts of the Swiss and Italian Alps upright hives were kept on shelves under the wide eaves (Figure 32.2e). In England they might be in a small shelter built against a house wall.

32.23 Wall recesses and their use for hives

From early times, in regions where stone walls were common, recesses were incorporated in them to serve

Figure 32.2d Hives of *Apis cerana* in Bali, Indonesia, hanging under the eaves of a house, 1972; they were made from parts of the coconut palm (photo: R. Verhagen).

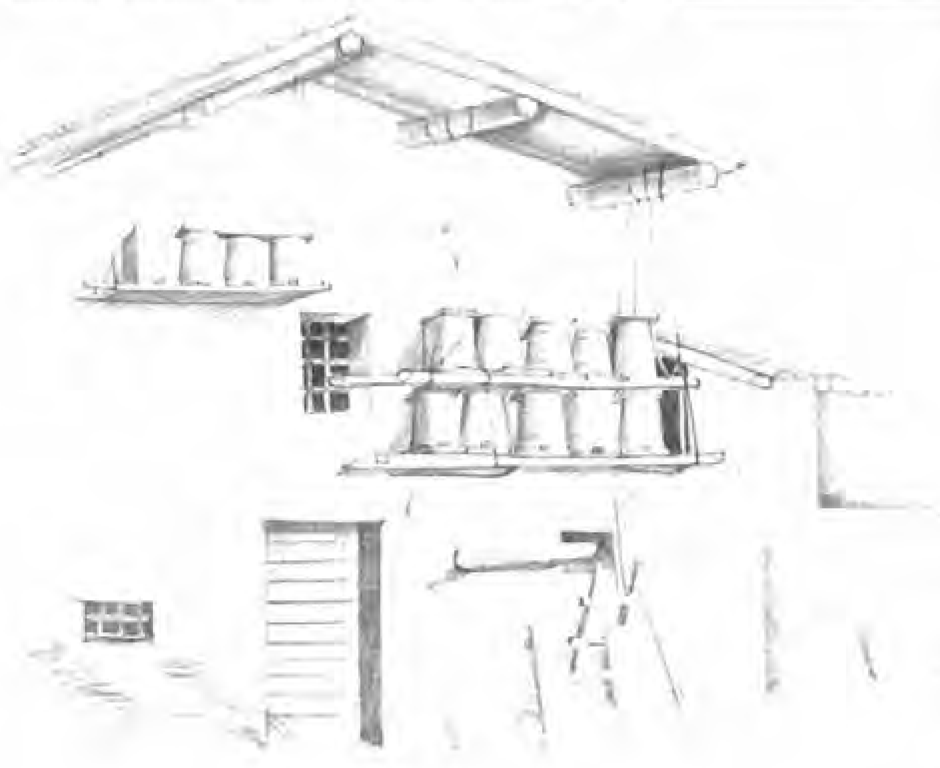


Figure 32.2e Upright hives of *Apis mellifera* on shelves suspended above head height, Ugazzo, Ticino, Switzerland (drawing by B. Tappolet in Sooder, 1952).

Figure 32.2f Woven skep in a wall recess, Katakilo, Andros, Greece, 1994 (photo: Th. Bikos). In use, the slab in front is leant against the hive to give extra protection, and the bees fly out under the curved gap.

a variety of purposes. Some that were made about 2500-2000 BC in Neolithic houses still exist at Skara Brae in Orkney, north of Scotland (Crane, 1983a, Fig. 178). Much later, recesses were built in stone walls specifically to accommodate hives. For instance in some Aegean islands deep recesses were made in south-facing walls that supported cultivated terraces on hillsides, to house long horizontal hives (Section 22.33). In his 1790 book (Vol. II, pp. 20-25), della Rocca gave a detailed description of such recesses on Syros; they were roofed with large slabs to keep the hives dry, and were packed with hay to provide thermal insulation. Figure 22.3c shows several hives in their recesses at Katakilo on Andros, and at Makritichi nearby there are between 1000 and 2000 similar recesses, many still occupied (Bikos, 1994). In a number of places on the south-west coast of Andros, many wicker skeps were housed in shallower wall recesses, as in Figure 32.2f. In mainland Greece, 98 recesses for upright top-bar hives were found near Mycenae (Figure 32.2g) but have since been demolished.

In several parts of western Europe skeps were housed in wall recesses, although this was never the most common type of apiary, as in Andros in the 1990s. In France over 100 sets of recesses (*niches des abeilles*) have been recorded, most in hill country of the south. Figure 32.2h shows an example, and Chevet (1995) published others.

The average number of wall recesses recorded at one site was 16 in France (the maximum was 100). In countries where bees were kept in a similar way, a beekeeper in a good honey-producing area tended to have more hives than a beekeeper in an area where honey yields were low. In Britain – where the Scottish term bee boles has been commonly used for these wall recesses – the average number was between 4 and 5.

Lawson in England referred to the recesses in 1618: 'Some ... use to make seats for them [the bees] in the stone-walls of their Orchard, or Garden, which is good, but wood is better.' A painting of a garden in the south of England, made about 1700, includes wall recesses with skeps in them, and their owner (Figure 32.2i). Figure 32.2j shows locations of 678 sets of wall recesses (together with 117 other protective structures for hives) recorded in Britain and Ireland up to 1981, and a further 300 sets of recesses have been recorded since. Most recesses were near a house, and over 80% were in a garden wall, a house wall facing a garden, or an orchard wall. They faced in directions recommended by writers from Roman times on-

Figure 32.2g Some of 98 wall recesses used for top-bar hives, a few km east of Mycenae, Greece, 1952, IBRA Register G1 (photo: Brother Adam). A factory was later built on the site.

Figure 32.2h Thirty wall recesses in two tiers, facing across a vineyard at La Chartreuse de Bonpas, Vaucluse, France, 1974, IBRA Register F2 (photo: R. Verhagen).

wards: about half to the south and a quarter to the south-east or east. They were found in walls built during every century from the 1100s to the 1800s, the greatest number probably in the early 1700s. Major aggregations occurred where the rainfall was high or there were harsh east winds in winter, but bee forage was good and beekeeping could be profitable if extra protection was provided. The 1981 records and an analysis of them have been published (Crane, 1983a), also details for Yorkshire (Walker, 1987), Scotland (Walker, 1988a), Kent (Walker, 1988b), Wales (Walker & Linnard, 1990), Cumbria (Walker & Crane, 1991) and Devon (Walker & Ogden, 1995).

Figure 32.2i Painting on wood showing wall recesses in the garden (IBRA Register 131), Charity Farm in Somerset, England, c. 1700 (infra-red photo: H.C. Tilzey).

Section 16.5 discusses wall recesses in which colonies of bees were housed directly; they were built in a latitude belt between about 35° and 50°N. Recesses built to house hives are in general found north of that belt.

32.24 Hives on a ledge in a rock face

In a few places, where it was the only way of protecting hives against bears, they were placed on a ledge in a rock face, although this was inconvenient for the beekeeper.

On the side of deep gorges of the river Véro in the Spanish Pyrenees, ledges protected by rock overhangs and facing between south-east and south-west were used for apiaries. Chevet and Chevet (1987) described 17 of them in detail, and Figure 32.2k shows one. The photograph in Figure 32.2l, taken from that apiary, shows a single 'satellite' hive a

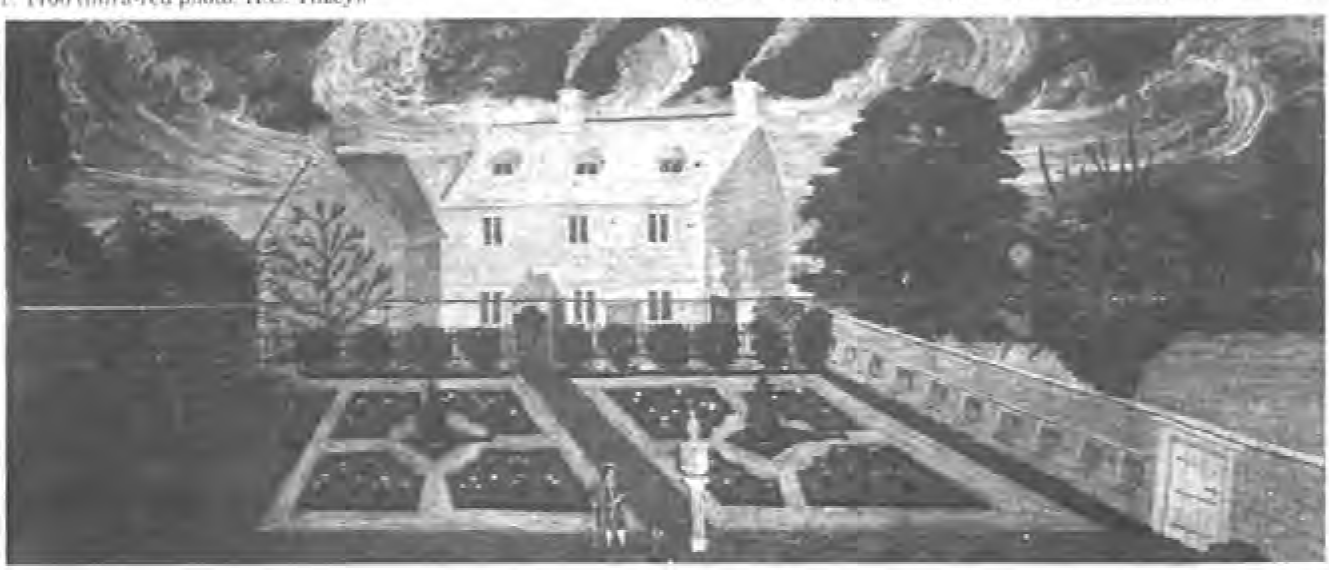


Figure 32.2j Map of Britain and Ireland showing locations of wall recesses and other structures for housing skeps: bee shelters, bee houses and alcoves (map prepared by P. Walker in 1981).

Figure 32.2k Apiary of cylindrical woven hives on a ledge in a limestone rock face, near Barfaluy, Véro gorge, Upper Aragon, Spain, 1987 (photo: R. Chevet).

Figure 32.2l View from the apiary (Figure 32.2k) showing a satellite hive on a ledge nearby (photo: R. Chevet).

short distance away; such a hive was often found near other apiaries in the area, and was probably intended for occupation by a swarm. An apiary on a rock ledge contained between 10 and 30 horizontal hives, stacked in two or three tiers on a base of stones or a pair of cross-poles, and covered with a layer of brushwood; sometimes a retaining wall of stones had been built at each end. Access to the apiaries was usually by clambering down from the top of the cliff face. It is not known when these apiaries were built, or last used, but in 1987 none of the hives contained bees.

In eastern Turkey upright hives were occasionally kept on such a ledge.

32.3 Hives in a purpose-made building

In some cool temperate regions, the housing of hives in or adjacent to a wall was developed further by building structures specifically for them.

32.31 Open-fronted shelters

Since mediaeval times, horizontal or upright hives were commonly housed in an open-fronted shelter in western and southern Europe (Armbruster, 1928). Two substantial end walls usually supported the roof and also the shelf or shelves; these were built against an existing wall, or the whole was a free-standing structure with an integral back wall. Hives – usually between 2 and 50 but sometimes more – were placed in a row, on a single shelf or on two or three shelves or piled on each other in tiers. Figure 32.3a shows a German shelter from 1502. In England, Lawson (1618) described a shelter (Figure 53.3c) as 'a Frame standing on posts with one floor (if you would have it hold more Hives, two floores) boarded. … In this frame may your Bees be dry and warm ….' His shelter containing 18 skeps had two parts at right angles, like the later Dutch shelter in Figure 32.3b.

Few of these hive shelters seem to have survived in continental Europe, but in Britain 85 have been

Figure 32.3a Woodcut by Johann Grüninger showing straw skeps in two simple bee shelters (Sebastian Brant's *Georgica*, Strassburg, 1502).

Figure 32.3b Bee shelter with straw skeps, illustrated by J. van der Groen, gardener to the Prince of Orange (1670).

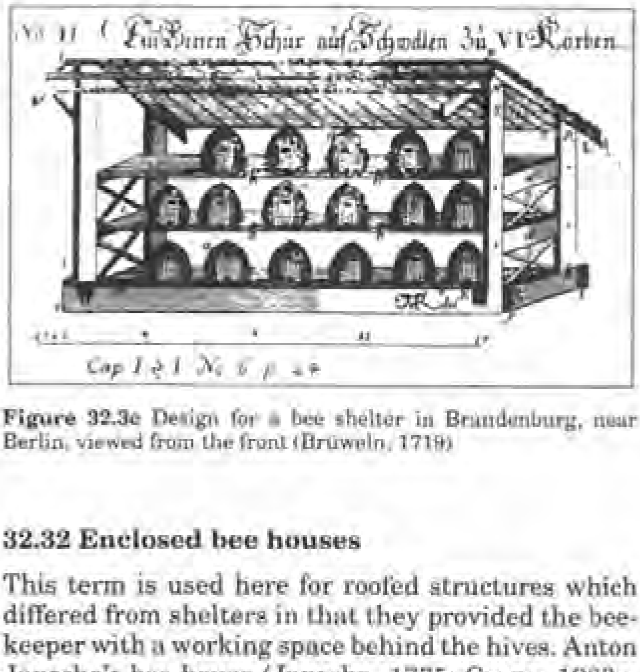


Figure 32.3c Design for a bee shelter in Brandenburg, near Berlin, viewed from the front (Brüweln, 1719).

recorded since 1950, many in areas of north-west England where stone was the common building material. They were constructed in the 1600s or later, and usually held between 2 and 10 skeps. Crane (1983a) and Walker and Crane (1991) gave details.

Bee shelters were much used in Slovenia, Austria and parts of Germany, and Figures 26.2g and 27.2c show examples. By the 1700s, designs for large wooden ones were published; Brüweln's (Figure 32.3c) was 4.5 m long, 3 m high at the front and 0.6 m deep; each shelf held 6 skeps. Figures 22.1d and 35.3c show shelters for horizontal hives in Sicily and Morocco, respectively, and Section 31.24 quotes a description of a type common in Vermont, USA, in the late 1800s.

32.32 Enclosed bee houses

This term is used here for roofed structures which differed from shelters in that they provided the beekeeper with a working space behind the hives. Anton Janscha's bee house (Janscha, 1775; Crane, 1983a, Fig. 210) in Carniola, part of Slovenia, was probably designed between 1769 and 1773 (see end of Section 25.6), and is rather similar to Brüweln's 1719 bee shelter shown in Figure 32.3c, but with a door leading to the beekeeper's working space at the back.

The bee house, commonly used for upright hives, was a later development than wall recesses or open-fronted shelters, and was a special feature of central European beekeeping from the late 1700s until the early 1900s. However, hives in an enclosed structure were mentioned in *Leges Barborum* dating from the 500s (Section 26.21). In later centuries bee houses

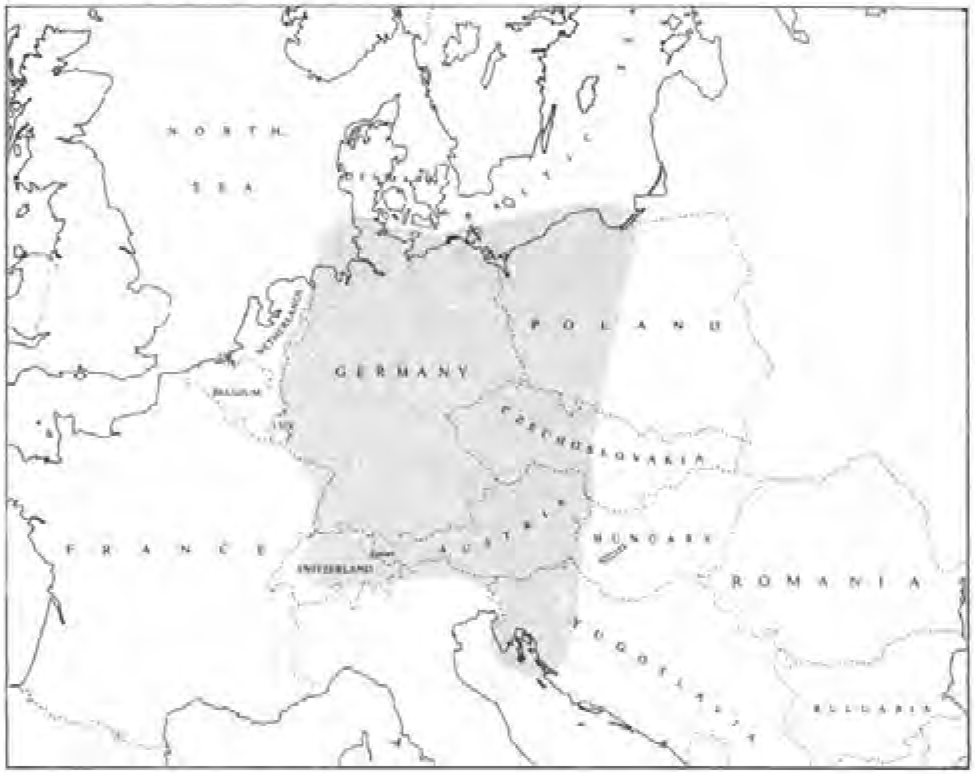


Figure 32.3d Central area of Europe (shaded) in which traditional hives were commonly kept in a German-type bee house (Crane, 1983a). Such bee houses were later used for movable-frame hives.

were characteristic of the area where the German language was well known (Figure 32.3d), which included present-day Germany, Austria, parts of Poland, Czech Republic, Hungary, former Yugoslavia, and also of Switzerland. Books published in German by beekeeping leaders – for instance Dzierzon (1848), Berlepsch (1860) and Dathe (1870) – spread and reinforced a style of beekeeping with back-opening hives (e.g. Zander, 1923; Gerstung, 1926), which could be operated most conveniently inside a bee house. The bee house in Figure 32.3e had been in use for many years, and I was told that hives had been kept on this site for 550 years. Some bee houses blossomed into elaborate buildings which

Figure 32.3e Bee house of the Rösch family at Grünsberg near Nuremberg, 1951 (photo: E. Crane).

provided the beekeeper and his friends with a much valued retreat. In Britain, bee houses seem to have postdated Janscha's 1775 description, but they were never common. Most had fully built walls with a separate flight hole for bees from each hive.

Outside the area shown in Figure 32.3d, bee houses with a working space behind the hives were also used for horizontal hives; 45 were recorded in part of Upper Aragon in Spain, and near 8 of them was a 'satellite' hive such as that in Figure 32.2l (Chevet & Chevet, 1987). Section 22.14 describes an old bee house in Corsica.

32.33 Structures used in winter only

At a temperature around 4° the energy expenditure and food consumption of a winter cluster of *Apis mellifera* are minimal. In some colder parts of northern Europe, special structures were built for wintering bees, with sufficient thermal insulation to maintain an equable low temperature throughout the winter, although probably not 4°, and they were kept dark but ventilated. Hives were placed inside in autumn when the weather became too cold for the bees to fly. In Britain Malynes (1622) gave instructions: 'In December house your bees, if they stand cold; and in the North house all.' They were left inside until temperatures allowed flight in spring, and fresh pollen became available.

Windowless winter bee houses were built above ground, and Figure 32.3f shows one at a farm in the Isle of Man (where 11 outdoor wall recesses had been built about 1550). More than twenty other past winter bee houses have been found in Britain and Ireland, of which the largest, at Castlecarra, Co. Mayo, had 46 wall recesses for skeps (Crane, 1983a). In Scotland, ice houses were occasionally used for wintering bees, and in Italy a wine cellar: Evelyn (c. 1655) referred to a 1648 book by Vincenzo Tanaro: 'They frequently set their weakest hives in the Wine-Cellar, where they will maintain themselves with the scent of the Wine till the Spring.'

Cellars built specifically for wintering bees were usually half underground. They were widely used in Russia until well into the 1900s, and were also common in North America, where Doolittle's cellar (Figure 41.2d) was built into a hillside in 1888; it held 128 movable-frame hives in 16 stacks of 4 along each of two long sides. It was entered by an anteroom 'in which I light my candle', and then two air chambers, all designed to prevent the entry of warmth, cold or light (A.I. Root, 1895). Later developments in Canada were described by Pettit (1917), and in the USA by Phillips and Demuth (1918). McCutcheon (1984) continued the story up to the 1980s and the production of fully automated above-ground winter bee houses.

32.4 Hives fixed high in trees

In much of tropical Africa the honey badger or ratel (*Mellivora capensis*, Section 5.3) quickly destroys any hives of bees it can reach. Partly for this reason, most hives were kept up to 12 m above the ground in trees, where the bees were also less likely to be disturbed and alerted to sting; see also Section 28.1.

Figure 32.4a shows hives suspended from ropes made of plant fibres; alternatively a hive was wedged in a fork of the tree, or attached to a forked stick which was then hooked over a lateral branch. The

Figure 32.3f Winter bee house at Ballachurry, Isle of Man, IBRA Register 141, in 1952 (photo: T. Rimmer). *left* Exterior, showing the upper entrance door. *right* Interior, showing some of the 31 recesses.

Figure 32.4a Five log hives hung in a tree, Kenya, c. 1970 (photo K.I. Kigatiira)

number of hives that could be sited in one tree depended on its size and growth habit; in the past it might be up to 10, but as traditional beekeeping declined there were rarely more than 5. In addition to increasing security, placing hives in trees in the tropics reduced stress on the bees, since they were at a more equable temperature through the hours of day and night than those near the ground, and had some shade. (Both logs and pot hives were fixed in trees outside Africa, for instance in Sri Lanka; Punchihewa, 1994.)

In northern Europe upright log hives were placed in trees when hive beekeeping first developed from tree beekeeping (p. 226), and Figure 26.1a shows an example. This practice also occurred in eastern Turkey (Crane, 1983a), but may not have been widespread.

32.5 Hives in the open, on the ground or on stands

There were various types of apiary in the open, and Figures 25.3b and 26.2i show examples. Such apiaries became almost universal later, where beekeeping with movable-frame hives was mechanized.

32.51 Stacks and tiers of horizontal hives

This is the earliest type of apiary known, from illustrations made in Ancient Egypt (Section 20.3). In the many Mediterranean areas where horizontal hives were cylindrical or rectangular, it continued through the centuries. In Figure 20.3b from Ancient Egypt, three hives are on a low platform, all at a convenient working height. A similar arrangement was adopted in Ancient Rome; a description is quoted in Section 24.1 under *Columella*. It was common in many Mediterranean regions, and in northern Spain and in Asia Minor some apiaries still conform to the Roman description.

In 1928 Mellor found that a stack of hives in Egypt commonly contained 7 or 8 rows, up to 500 hives in all; the outside ones were often left empty as in Figure 20.5b, and provided the rest with some insulation from the heat.

The usual Maya apiary in Mesoamerica (Figure 30.2e) may be included in this Section, since each row of hives rested on the one below. Figure 30.2c indicates the possible layout of an early apiary (before 1500).

32.52 The apiary in a general-purpose enclosure

Early gardens were enclosed by a wall, fence or hedge to provide security, and were likely to be the chosen site for hives placed in the open, or in a wall or other structure. According to an Assyrian record from the 700s BC (Section 21.1), the ruler who brought bees from the mountains, probably placing them in his garden, and his gardeners dealt with the honey and wax produced.

Roman authors described gardens in relation to bees and beekeeping, and Varro (III.16.10) referred to two brothers Veianius whose father had left 'only a small villa and a bit of land; ... they had built an apiary entirely around the villa, and kept a garden.' He listed the plants they grew for the bees. In northern Europe, hives were also commonly within the same enclosure as the house, often in a garden. Hives of bees in a garden or courtyard were especially protected in early mediaeval Irish laws (Section 27.52): theft of them was treated as theft from within a house. In *Les très riches heures du duc de Berry* from the 1400s, the February scene shows four skeps on a low stand just inside an enclosure that contains the house, sheepfold and farmyard. In the 1500s similar groups of hives were depicted in François de Rohan's *Fleur de vertu* and elsewhere.

John Evelyn started his section on bees in *Elysium Britannicum* (c. 1655) with a short history of apiaries in gardens in Ancient Rome. He wanted the bees to be 'one of the rarest, and most considerable Ornaments of our *Elysium*', and they were looked after by

the gardener. Evelyn got Moses Rusden appointed by King Charles II as the King's Bee Master (D.A. Smith, 1965), and Rusden referred to hives 'in the Royal Garden' in 1679. One of David Loggan's drawings of Cambridge colleges (1690) included an apiary of three skeps on stands, just inside the boundary wall of the garden. A few skeps – each on a stone or wooden stand, and protected by a hackle or broken crock – were a feature of countless English cottage gardens. Figure 27.2f shows an apiary of ten hives in the corner of a Swiss vegetable garden in 1793. In Asia many apiaries of *Apis cerana* are similar, for instance that in Figure 29.4c.

In the Netherlands, special arrangements had to be made for apiaries in the 1920s, when Police Regulations prohibited anyone 'to keep bees and let them fly out' in certain large towns. In some of them, beekeepers established a 'bee park' outside the town in which each participant had a plot for his apiary, combined with a garden for growing plants and for recreation; Kroes (1951) described the Amsterdam Bee Park.

32.53 A purpose-built enclosure as an apiary

In Europe, many past apiaries away from houses were enclosed by a fence, wall or earth bank, and examples given here indicate the wide variety of responses to local requirements. Palladius' Latin work on agriculture written in the 300s (end of Section 24.1) – probably the copy in Colchester Castle – was translated into English about 1420 (Lodge, 1873), and it included one of the few beekeeping texts then available in English. The first few lines described the apiary and were followed by a long list of plants to be grown there.

> The Bee-yerd be not ferre, but faire asyde
> Gladsum, secrete, and hoote, alle from the wynde
> Square, and so bigge into hit that no thef stride.
> Thaire floures in coloures or her kynde
> In busshes, treen, and herbes thai may finde ...

In 1659 John Winthrop reported that in Thracia, 'a little from Constantinople', he had seen 'a yard hedged in, and of a good bignesse filled with beehives, standing upon the very ground only a flat stone or board under them, and as thick together as the hopp-hills in an hop-yard: and so many of them, that I could not conceive any possible meanes to attend and preserve them by way of swarming.' The 1720 Spanish apiary in Figure 25.3c was comparatively large, and no plants are shown.

In the Ukrainian plains in the 1600s/1700s, a peasant apiary of upright log hives was described as circular, about 150 yards (m) across, enclosed by a fence of reeds and brushwood, with a thatch 1.5 m wide supported on the inside by poles. The hives stood under the thatch, and fruit trees were planted in the centre. To prevent snow penetrating in winter, a bank of earth was thrown up and underwood planted round it (Latham, 1955). Figure 32.5a shows a somewhat similar thatched skep apiary enclosed by a wattle fence in Romania close to the Ukraine border. Another in the Debrecen area of Hungary was published by K. Szabo (1977, Fig. 6). In parts of Ukraine and Kuban, the apiary (*pasek*) was a sheltered place protected by a ring of trees cut so that their branches made a thick barrier against animals.

Many other ingenious types of apiary were probably built in different areas – using local materials and skills – to protect hives from the local hazards, and further searches should uncover vestiges of others. Some of the most spectacular, on mountain sides, built to provide protection against bears, have been located within the last few years. First Dendaletche (1986), who studied bears in an area of the Cantabrian mountains in western Asturias, north-west Spain, found hives enclosed inside massive stone walls (Figure 32.5b); the name for them was *cortin*, and Spanish *cortinal* is fenced-in land. Chevet (1990) recorded more than 50, of which I saw 30 in 1991; see also Chevet (1995). Most of those surviving were round or oval with a diameter between 5 and 20 m; a few were rectangular. The wall, usually 2-3 m high, was topped with large overhanging slabs of schist to prevent bears climbing over. The beekeeper entered either through a small door or by removable stone or wooden steps. A *cortin* was usually on a south-facing

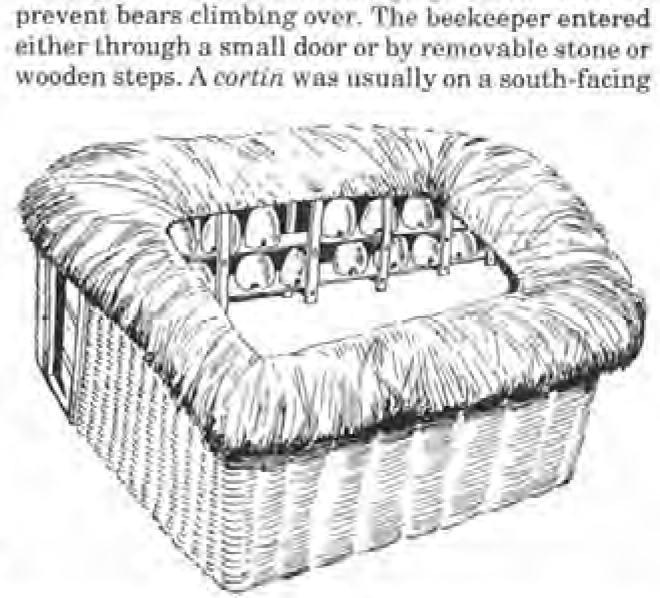


Figure 32.5a Apiary inside a wattle fence, with skeps on shelves protected by a thatched roof, Panyola, Szatmárin, Romania (Gunda, 1992).

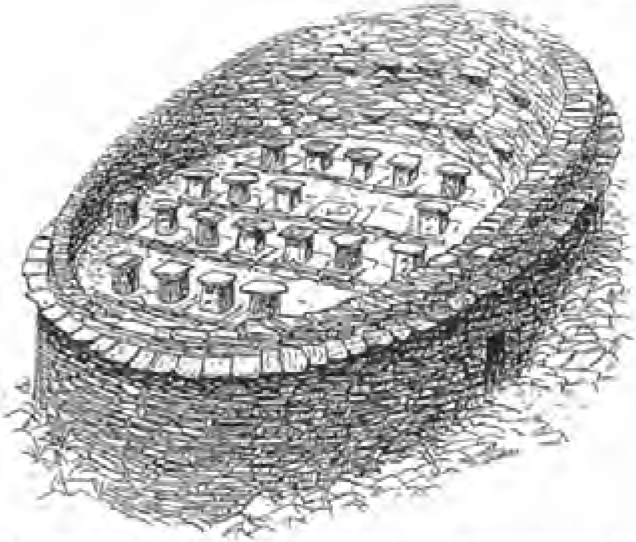


Figure 32.5b Oval *cortin* in western Asturias, Spain (drawing by Grana in Dendaletche, 1986).

Figure 32.5c Enclosed apiary (*cá d'arbiné*) near La Brigue in the upper Roya valley, France, 1994 (photo: E. Crane).

slope, and terraces were built inside to accommodate rows of hives facing downhill, as in Figure 32.5b; any hives still present in the 1990s were upright logs. The *cortin* may have been devised in the 1700s when western Asturias was rich in bee forage and a peasant owned up to 200 hives, producing enough wax to sell in León and Madrid (López Alvarez, 1991). Beekeeping declined afterwards.

In Galicia in the far west of Spain, there was a type of apiary similar to the *cortin* called *albariza* – the Galician word for apiary (Solís Fernández 1987; Chevet, 1988c; Fresno Vidal, 1988). In another apiary, megaliths had been erected round most of the inner side of the enclosing wall to support roof slabs (more than a metre wide), under which between 30 and 60 upright cork hives were placed. This is like a stone version of the Romanian apiary in Figure 32.5a, and both could be described as a shelter (Section 32.31) whose rear wall enclosed the apiary.

In the upper Roya valley in Alpes-Maritimes near the French-Italian border, Masetti (1994, 1996) found more than 70 apiaries on south-facing mountain sides, remarkably similar to the *cortin*; Figure 32.5c shows an example. Around Tende the local name was *naijou*, and round La Brigue *cá d'arbiné*. Many were about 8 m across and 10 m long (uphill), and the wall was up to 5 m high at the back. Terraces remained in a number of the enclosures, and sometimes a few upright log hives on them. Archives in Nice (Masetti, 1955) included a copy of a by-law dated 1752 which set out punishments for the theft of fruit and vegetables, and of hives from *najsi* (plural of *naijou*). So these enclosures date from the 1700s or earlier. According to a talk on the brown bear in the French Alps, a bear was last seen in 1937 and the last traces of one in 1940 (Érome, 1990).

In 1993 Dias published an earlier reference to such enclosures, in Gerês, north Portugal. In 1732 Father D. Jeronymo Contador d'Agote described *silhas* with walls about 5 m high. A *silha* was constructed of dressed stones, larger ones being used at the top of the wall than at the bottom, so that the outer surface sloped outwards towards the top – as an additional deterrent to the bears 'which roam the mountains and breed in the region'. Dias also gave details of surviving *silhas* – very similar to the *cortins* in Spain – and of hives used in them.

Part VI

HISTORY OF PRACTICES IN BOTH TRADITIONAL AND MOVABLE-FRAME BEEKEEPING

Chapters 33-37

33

History of Protective Measures against Stinging by Bees

33.1 Introduction

33.11 Stinging by bees and its effects on man

A worker honey bee uses her sting in defence of her colony. Some species and strains of honey bees are more readily alerted than others to sting a potential intruder. For instance tropical African honey bees – which evolved in the presence of many enemies – are more readily alerted than European honey bees. When a tropical African bee stings, the alarm pheromone she produces very rapidly alerts others nearby to attack. The alerting behaviour is less marked in most Asian honey bees of the species *A. cerana* and *A. florea*, but much more in *A. dorsata*. In this Chapter the bees referred to are *A. mellifera* unless otherwise stated.

The bee's sting (Figure 50.1a) has two sharp lancets which can pierce relatively tough human skin, and they are barbed like fish hooks so cannot be withdrawn. When the bee tries to free herself after stinging, the whole sting apparatus usually breaks off and she then dies. These facts were known in Ancient Greece.

> Bees that sting die from their inability to extract the sting without at the same time extracting their intestines. True, they often recover, if the person stung takes the trouble to press the sting out, but once it loses its sting the bee must die. (*Historia animalium* IX.40.626a)

> Neither will the sting grow again if the bee loses it, but the creature will die of the loss. (Aristotle, *Historia animalium* III.12.510a)

In a human being, the results of being stung are likely to be instant pain and a more prolonged weal and flare, with itching and swelling; these effects are due to release into the tissues of histamine, a very potent substance which in excess can cause collapse and shock. Most beekeepers, who are stung fairly frequently, develop some immunity and react only slightly to stings. Riches (1991) explained that, after first being stung, people develop protective antibodies, mainly of the immunoglobulin G type (IgG), which combine with the venom proteins to form biologically inactive complexes that the body can eliminate. In addition, people who handle bees learn not to flinch if they feel any pain, so they do not alarm or injure bees and thus induce more stinging. Severe results of being stung are likely to follow only if a person receives hundreds of stings at once, or if he or she is hypersensitive (allergic) to bee venom and may therefore suffer anaphylactic shock, or if a sting is received in the eye which may cause blindness – or in the mouth which may cause swelling and thus impede breathing. The number of people who are hypersensitive to venom from bees or other stinging insects is very small, probably a few per thousand. Instead of generating IgG antibodies these individuals form a different immunoglobulin (IgE) which combines with venom proteins in the body, releasing histamine and other active agents. Riches (1982, 1989) gave further details.

Here, Section 33.12 cites some historical references to stings received by individuals – some of whom were not handling bees – and Sections 33.2-33.7 trace the history of protection (or lack of it) for individuals who put themselves at risk of being stung. Section 33.8 summarizes the history of treatments for bee stings. Human attitudes to bees and stinging by them have been discussed elsewhere (Crane, 1976b).

33.12 Some historical and other references to stinging

In Ancient Greece it was recounted that bees asked Zeus to ensure that their stings would prove mortal to man, who tried to steal their honey, and Zeus punished them for their malice by decreeing that they themselves should die after using their sting. Antipater of Thessalonika reacted vigorously to a story in which a baby was stung to death by bees; 'You savage horde of bees, you killed young baby

Hermonax while he was crawling to your hive looking for honey. You had often fed him before, and now you have stung him to death.' Figure 7.3a shows a legendary scene from Crete in which naked men were trying to beat off a crowd of bees, painted on an Etruscan vase.

Beck (1935) cited a number of later records of deaths resulting from bee stings – mostly of a child, or of an adult stung on the head – and some of the individuals were probably allergic to the venom. In 1880 the Paris Board of Health received numerous complaints about stinging by bees kept in the city, and subsequently published a detailed report of 16 fatalities from the stings.

In some early laws, stinging by bees was dealt with in the same way as damage by other livestock. In Irish laws known in written form from the 600s-700s (Section 27.52), paragraphs 27-33 refer to injury caused by bees stinging a person. If bees sting a man who is robbing, seizing or moving them, or 'looking at them over their hives at the time when they are swarming', they are immune from blame (§27). But 'it is wrong for them to attack anyone going past them on his way who is doing them no harm or illegality' (§28). 'This is an injury which entails his sufficiency of honey for the man who is stung there, with an oath from him that he did not kill the bee which stung him; for if it is killed, it compensates for its offence as in every other case' (§29). (The usual natural death of a bee after stinging was not equated with its being killed, and was perhaps not recognized.) In the Ancient Welsh laws first written in the 1200s (Section 27.52), if bees in a swarm killed a man, the swarm was to be handed over like a guilty person, if it could be found. Otherwise, its owner had to pay its legal value for the dead man. Crane and Walker (1984/85) gave more details. In late mediaeval Germany, when a complaint was laid before the Diet (Council) of Worms in 1521 that bees had killed a child, the bees and their hives were condemned to be burned in the public square (Beck, 1935).

The possible serious consequence of receiving a sting in the eye was known in Ancient Greece: Ovid's *Ibis* used the expression: 'May a bee plunge her sting into your eyes' (241). In the early AD 600s, Congal, King of Tara in Ireland – where there was a famous mead hall (Figure 48.3d) – was blinded in one eye by a bee sting and, according to the Irish laws referred to above, this blemish 'put him from his Kingship' (§31-§32). Paragraph 30 of the laws said that if the bees have blinded an eye, 'the injury requires the casting of lots on all the hives; whichever hive it falls upon is forfeit for the bee's offence.' Croft (1989) detailed some eye injuries from stings in later periods.

Most of the recent references are to death from anaphylactic shock. A French report of such a death from a bee sting in 1762 was referred to briefly by Feinberg *et al.* (1956), and two such deaths in the early 1800s in the USA were recorded in some detail. In Wardsborough in Vermont, Ebenezer Fisher was stung by a bee on 'the septum of his nose', while dealing with a swarm on 17 July 1811 when he was 35, and he died 20 minutes later (Dean, 1974). In Chapin, NY, Timothy Ryan (or Hyne) died in 1814 at the age of 65, after being stung 'in 4 or 5 places on the side of the face and neck'.

In many centuries stinging bees were used as a military weapon and as an instrument of punishment; see Chapter 50.

33.2 Getting honey without specific protection

Where little clothing was normally worn, as in tropical Africa, garments were often removed before a bees' nest was tackled, otherwise bees could become trapped and sting the wearer. In Kenya, Kikuyu and probably also Kalenjin honey hunters customarily stripped down and went honey hunting with nothing on, but Pokot people – who were very clever beekeepers – did not bother to strip (Nightingale, 1983).

A degree of indifference to stings is apparent in many accounts of getting honey from natural nests. In Sri Lanka, the Vedda honey collector referred to in Section 15.22 was covered in stings after collecting honey from *Apis dorsata*. Companions picked them off his body but, impatient of this, 'he smeared himself with sand so that the ants could not worry him, and was soon asleep'. Also in Sri Lanka, Robert Knox (1681) described honey collection from nests of *Apis cerana* in trees or underground. 'The men ... are not afraid of their stinging in the least, nor do they arm themselves with any cloths against them.'

Figures 33.2a and 33.2b show the vulnerability of an unprotected person exposed to bees near a hive. Someone stealing honey from a hive or owned nest would not necessarily be experienced in avoiding stings, or immune to their effects, and a Welsh poem from the early 1400s quoted in Section 14.5 said of a honey thief: 'His cheeks are swollen, And he has a large nose like a Jew.'

From early times honey hunters used smoke to kill bees or drive them away from a nest before they took the honey combs; later the smoke was used in a more controlled way to drive bees off combs to be harvested from owned nests and from hives, without killing any bees (Chapter 34). Skilfully applied, the smoke also

Figure 33.2a Boy being stung by bees; illustration in a Latin bestiary, England, late 1100s (British Library, Add. MS 11283).

gave the operator some protection against being stung. Also, honey hunters probably noticed that, where their bodies became smeared with honey, bees alighting fed on this and were then unlikely to sting. Such an emergency protection was available to anyone, once the first honey had been obtained.

Carlisle (1967) recounted an incident in December 1863 during the American Civil War. A foraging party of Ohio Cavalry found an apiary of 150 bee gums (log hives), and collected much honey after smearing their hands and faces with honey. A less knowledgeable party of Illinois Infantry also tried to get honey, but suffered many stings until the Ohio men showed them what to do.

33.3 Forms of protection apart from clothing

33.31 Propriety in human behaviour

Honey hunting and collecting

When a person took honey combs from a colony of bees, he was least likely to be stung if he acted slowly and gently, making no sudden movements, and also if he avoided operating in conditions when bees were most likely to sting: just after the end of a honey flow, in thundery weather, or when the colony was under stress from shortage of food or from ant attack.

The work of harvesting honey was often restricted by inheritance or custom to certain individuals within a group. Each individual who did it would learn appropriate behaviour from his father or from other elders. Lao people in northern Thailand believed that an immunity to effects of stings was passed down from father to son, although in fact a learner would develop immunity as a result of being

Figure 33.2b Woman trying to protect her face against bees while handling a hive; French manuscript from the 1400s of Dioscorides' *Tractatus de herbis* (Biblioteca Estense, Modena, Italy).

stung (Section 33.11). A man working at a nest might draw hair over his face to protect his eyes, mouth and nose. Where daylight was not essential for the work, honey might be taken on dark nights when the bees could not see to fly.

In many parts of the world traditional rules of propriety were followed before setting out on any type of hunting expedition, but this was especially important when dealing with bees, since these were widely supposed to be 'pure' creatures, with a keen perception of both physical and moral impurity in men – to which they reacted by stinging. Thus only men who were free from any impurity should go out to get honey. Among the Bassari in Senegal (Section 8.2) requirements included sexual abstinence by the man for the preceding 2 or 3 days, and by his wife while he was away hunting. Among the Gharti in Nepal, there must have been no recent death among near relatives, and the man's wife must not be menstruating or pregnant. Before setting out, the honey collector had to fast, and then to eat 'without contamination'.

In parts of the tropics where both honey bees and stingless bees were present, the risk to honey hunters of being stung by honey bees was partly counterbalanced by their greater honey yield and by the easier access to some nests which were built in the open. But I do not think the stinging propensity of different species of bees in an area was necessarily

a major factor in a honey hunter's decision as to which of the bees to tackle. However, during the period within living memory, the situation with tropical *Apis mellifera* in Africa has changed: men who robbed nests of bees were not all traditional honey hunters, and they left alone bees especially likely to sting (e.g. Nightingale, 1983), so more of these survived.

Hive beekeeping

It was known in the time of Aristotle that certain odours could alert bees to sting: 'They are annoyed by all bad smells and by the scent of perfumes, so much so that they sting people that use perfumes' (*Historia animalium* IX.40.626a). Section 20.4 quotes a statement from about 200 BC, that beekeepers in Alexandria had their heads shaved because of the bees' dislike of perfume. In Rome, Varro (III.16.6) and later Pliny (XI.19.61) wrote of bees stinging anyone smelling of perfume. Columella wrote (IX.14.3):

> Very great care must be taken by the man in charge ... when he must handle the hives, that the day before he has abstained from sexual relations, and does not approach them when drunk, and only after washing himself, and that he abstain from all edibles which have a strong flavour ....

Later, European beekeepers continued to believe that bees disliked impurity and unclean smells. One of the earliest English beekeeping books, by Thomas Hill (1568), said the following.

> The keeper of bees, which mindeth to handle and look into hives, ought the day before to refraine the veneriall Act, not a person fearefull, nor comming to the hive with unwashed hands and face: and one that ought to refraine in a maner from all smelling meats, poudered meates, fried meates, and all other meates that doe stincke, like as the Leekes, the Onions, the Garlike, and such like, which the Bees greatlie abhorre: besides, to be then sweet of body, cleanlie in apparell, minding to come unto their hives, for in all cleanlinesse and sweetnes the bees are much delighted.

Butler (1609) wrote similarly, and so did authors in the 1700s and 1800s. Bevan (1827) rejected 'bee dress' (except for the timid) and recommended a beekeeper, before going to his bees, 'first to drink or rinse his mouth with a little malt liquor; to wash his face and hands with the same, and to approach them with a bunch of sweet herbs in his hand, gently fanning his face with them, whilst he is in the vicinity of their domicile, and breathing as much as possible through his nose'.

Butler had learned to recognize the times and seasons when the risk of being stung was least.

> If you have anything to doe about your hives, the fittest time is in the morning, when the Bees are new gone abroad; and in the evening before they be come in: for then the weather being coole, and the company few at home, they are not so apt to be quarrelling, unless they be much provoked.

In some regions, the beekeeper was protected from most flying bees by the positioning of the hives, for instance in a long tiered stack worked from the back, as in Figure 20.5b.

33.32 Use of parts or extracts of plants

Plants discussed here were effective without being burned. Both honey collectors and hive beekeepers used local plants containing substances which repelled bees or pacified them, or both. Table 8.6B lists some of the plants used on *A. mellifera* in Africa and Europe, and Table 15.2A lists others used on *A. dorsata* or *A. cerana* in Asia; the plant material was usually rubbed on the body, or chewed and expelled from the mouth on to the bees, or both. In addition, Table 8.6A lists some plants burned to produce smoke which pacified or repelled bees; smoke from a few materials narcotized them, e.g. puffball (p. 344).

Roman authors mentioned a number of plants whose juice was rubbed on the skin (alone or mixed with oil or some other substance) to prevent bees stinging. Many European beekeeping books subsequently listed such plants, including sperage (asparagus), marsh mallow, fenugreek (*Trigonella foenum-graecum*). In the *Geoponica* (XV.6), Paramos mixed the juice of wild *malache* with oil, and poured it on to meal of parched fenugreek; he rubbed some on all exposed parts of his body, swallowed some and breathed into the hive 3 or 4 times.

33.4 Protective clothing for beekeepers 1400-1600, and its origination

Protective clothing was a feature of European hive beekeeping with *Apis mellifera*. It was less necessary with *A. cerana* in Asia, and hardly needed at all with

stingless bees (Meliponinae) in the tropics. It was probably not used in hot parts of the world where clothing covered only a small part of the body in everyday life. Most people collecting honey from natural nests probably wore no extra protection, and the protection worn by north European tree beekeepers in Figure 16.2b (1774) was perhaps transferred from hive beekeeping. In mediaeval northern Europe, everyday outdoor clothing covered most of the body except the face and hands. A beekeeper taking honey from a hive probably rearranged his clothing to cover his face as much as possible, and this is quite commonly done today by people who have no other form of protection. Nonnus, who lived in Egypt in the later Roman Empire and wrote between AD 431 and 471, described the mythical discovery of beekeeping by Aristaeus:

> He covered every limb from toenails to hair with a close-woven wrap of linen, to defend him from the formidable stings of the battling [armed] bees. (*Dionysiaca* V.247-249)

The toga then worn by men was a large plain piece of material draped to cover much of the body, and it could be drawn over the head as well.

The origination of face protection for beekeepers

The earliest known purpose-made protection against stings on the head and face appeared in western Europe about 1400. A common head-covering in mediaeval Europe was a hood attached to a cape fitting over the shoulders; the cape might be opened up to the neck, or closed and the whole put on over the head. Harrison (1960) dated the introduction of the hood into England at about 1160, and an illumination in St Swithin's Psalter (1150-1160, British MS Cat. Nero CIV) shows two shepherds wearing a hood with a shoulder cape closed at the neck, leaving a hole for the face. Such a hood could also be tied round the neck, and with a cover sewn over the face-opening it became a bee-proof protection for the head. The earliest known illustrations of a beekeeper wearing a hood that also covered his face are in mediaeval illuminated manuscripts; they show ordinary clothing worn on the rest of the body, except possibly the hands. The first (Figure 33.4a) is in a copy of Virgil's poems dating from about 1400, and close examination suggests that the entire (pink) hood and cape are of a soft pliable material (Jolly, 1991).

For many centuries, materials available for the face-cover gave the beekeeper only limited vision. A rigid translucent insert in the hood, which was an

Figure 33.4a Frontispiece to a French copy of the fourth of Virgil's *Georgics*, showing a beekeeper wearing a protective hood, tanging a swarm, c. 1400 (Holkham MS 307, reproduced by permission of the Earl of Leicester, Holkham Hall)

improvement, is first known from an illustration made in northern Italy in the mid-1400s (Figure 33.4b). The insert is shaped like half an egg, and may have been of woven cane – or of woven wire* as described in 1790 by della Rocca (Section 33.5). In some countries, including Hungary, Greece and Turkey, beekeepers still wear these wire masks sewn on to a hood (Figures 33.6a, *left* and 39.3b). Figure 20.5c(2) shows an Egyptian hood with a flat wire insert.

In Figure 27.1a a flat woven panel is fixed to the hood, and kept well away from the face by a deep rigid rim. This also gave very limited vision, and the clothes would not be nearly as bee-tight as those in Figure 33.4b. The beekeeper in Figure 35.2b (in 1555) saw even less.

Three Flemish engravings from the late 1500s show realistic details of communal work in the apiary by well protected beekeepers. In one by Hans Bol (Figure 33.4c), all four beekeepers appear to be wearing hoods and gauntleted gloves. The picture by Pieter Breughel (Figure 27.4c) shows long-sleeved skirted garments, and hoods which are apparently

*It has been suggested that this type of beekeeper's protection was based on wire fencing masks, but standard works on fencing (Castle, 1885; Beaumont 1970) make this seem unlikely. Also, European fencing masks had large apertures and protected only the face; they did not cover the head and neck (A.R.E. North, Victoria and Albert Museum, 1983)

Figure 33.4b Illumination at the head of the fourth of Virgil's *Georgics* by the 'Master of the Vitae Imperiatorum', Milan, *c.* 1450 (Bodleian Library, MS Rawl. G.98, SC 14825). The two beekeepers wear metal masks. Inside the initial P, the poet is shown writing the poem.

tucked in at the neck. The hood is fitted with a round insert woven from cane or other plant fibre, and little could have been seen through it. (The slender ungloved fingers suggest that the men might be thieves, e.g. Grimm, 1993.) Jan van der Straat (Figure 53.3a) shows hoods more like those in Figure 33.4b, but with no obvious rigid frame to the squarish insert; one insert at least was shown cross-hatched.

Although protective clothing was worn by some beekeepers in western Europe in the late 1500s, it may not have been in common use. In 1570 Liébault in France recommended the use of a mask and gloves when taking honey from from hives, but English beekeeping books published before 1600 (T. Hill, 1568; Southerne, 1593) did not mention it.

Protection for the hands

Gloves with gauntlets were widely worn in England for agricultural work by the 1300s. They were made of cloth or less usually of leather, with one section for the thumb and one or two others for the fingers (Cunningham & Lucas, 1967). Figure 33.4c (1582) shows beekeepers wearing such gloves.

33.5 Protective clothing 1600-1850

Butler's 1609 beekeeping book recommended chaste and cleanly behaviour as the means of obtaining 'favour of thy Bees, that they sting thee not'. But the reader was advised that it was 'better to stand upon your guard, than to trust to their gentlenesse'.

> For the safeguard of your face ... provide a purs-hood made of coarse boultering [straining cloth], to be drawn and knit about your collar: which, for more safetie, is to bee lined against the eminent parts with Woollen-cloth. ... [detailed instructions follow] Instead of this, you may use a Cypres Band or a Boulter, having a Handkerchiefe betweene your fore-head and it, to beare it out from the skinne, and your hat on your head to hold it fast. And if they be so earnest that you feare stinging your hands, put on a paire of woollen cuffes or gloves. When you have on this Helmet and Gantlets, as a man armed at all points, you may boldly deale with them.

Figure 33.4c Apiary in Flanders, with four well protected beekeepers, by Hans Bol, 1582. See text.

Figure 33.5a French beekeeper's hood, with horse-hair insert, tie-strings and part sleeves (Réaumur, 1740).

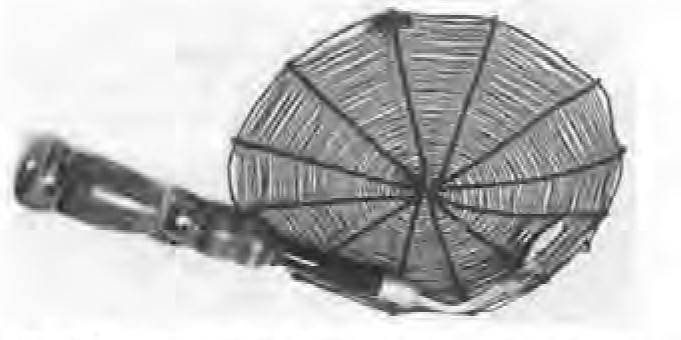


Figure 33.5b Dutch bee-veil insert and pipe smoker, early 1800s (Nederlands Openluchtmuseum, Arnhem AA 88196). The copper-wire insert is from Wageningen (diameter 21 cm). See also Figure 34.3a.

Beekeeper's protective clothing as used between 1400 and 1600, illustrated in Section 33.4, continued even into the 1900s except for changes in the fashion of everyday outdoor clothes. Books describing or illustrating it were published in France (Réaumur, 1740; della Rocca, 1790), Germany (Krünitz, 1774), England (Huish, 1815), and Switzerland (painting by A.S. v. Bonstettin, in Sooder, 1952). Some of the books provided detailed patterns for readers to follow. Réaumur illustrated a hood with an integral blouse-top, complete with ties round the waist and sleeves (Figure 33.5a). Figure 33.5b shows a surviving Dutch example, and Huish (1815) published one 'having a mask of iron wire, which is more commodious than glass, horse-hair, or gauze ....' I found no mention of protective clothing in English books by Purchas (1657), Worlidge (1676), Rusden (1679), Thorley (1744) and T. Wildman (1768).

Broad-brimmed hats were worn much earlier than hoods, for instance in Ancient Greece. They were in England by 1200, but although a brimmed hat could hold the veil away from the face, it seems to have been a late arrival in the beekeeper's wardrobe. Butler's hat in 1609 was worn only to hold the head covering fast. Figure 33.5c shows a beekeeper's hat and veil in France in 1846, with other protective clothes.

At the end of his Volume III, della Rocca (1790) showed a beekeeper's hood similar to those in Figure 33.6a (left). He explained how to make a mask for inserting in the hood. A flexible willow rod was bent into an oval slightly larger than the face, and three curved rigid metal wires were fixed across it later-

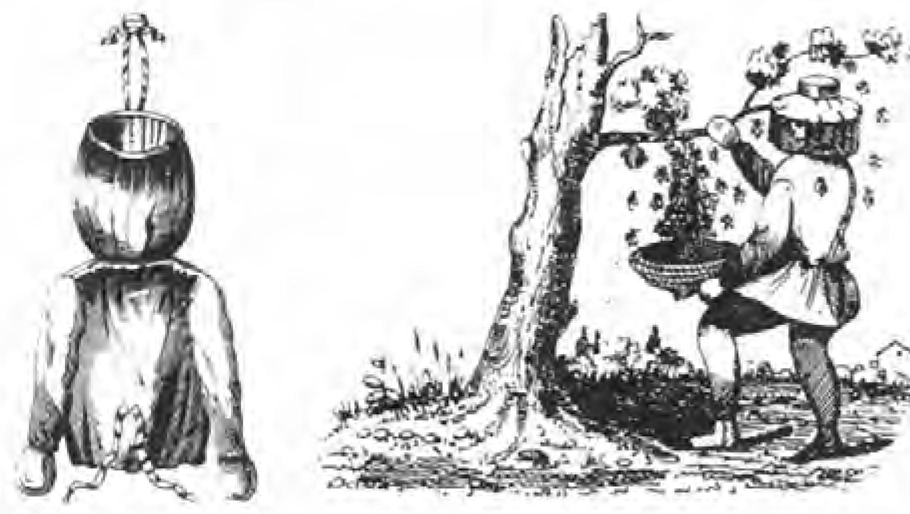


Figure 33.5c Brimmed hat as a part of French protective clothing (Debeauvoys, 1846). *left* Details of a workman's blouse with an integral veil and hand coverings, also tie-strings (to wear with a hat). *right* The garment worn with a hat, by a beekeeper taking a swarm.

ally. Finer wires were woven in and out at right angles to the laterals, and if necessary were fastened to them by further pieces of wire. (In 1790 such masks were manufactured and sold cheaply in Smyrna – modern Izmir – in Turkey, and in 1979 I bought one in Greece.)

In England, fabric was used instead of metal for the face covering. Mortimer (1707) had said that 'the general practice now is to cover the face with black Italian crape, such as is used at funerals'. Keys (1796) gave one of the earliest detailed directions for a veil of a type still much used; it was made of boulting cloth 'sewed to the brim of an old hat, when reduced to $2\frac{1}{2}$ inches [6 cm] in width', by gathering it up to a ferret binding [a tape] 'to let the crown through and encircle it close round'. Gloves were of oiled linen, or of thick tanned leather 'or other leather oiled only once: a portion of old stocking is to be sewed to the extremities to draw tight over the cuffs of the coat'. Finally 'an apron before will be useful to prevent these prying insects from tickling the belly'. Keys also described a hood 'calculated to carry in the pocket', and added: 'Women should not meddle with bees, without this bee-dress; nor then, without the addition of a man's coat, and I had almost said breeches also.'

John Hunter, an eminent English surgeon who published his observations on bees in 1792, constructed a 'wooden mask' to protect his face from stings. (After his death it was auctioned with many of his other possessions, and described by an inventive auctioneer as 'a covering for the face used by South Sea Islanders when travelling, to preserve their faces from snow storms'; Kobler, 1960.) Isaac (1803), who was much in favour of protective clothing, wore 'a neat veil of catgut, tied around the pole of his hat, the under part tied around his middle ...'. Nutt (1832) and Bevan (1827) rejected the use of protective clothing, but Bevan relented somewhat in his 1838 edition:

> Most practical writers on bees have regarded a bee-dress as a needful appendage to an apiary; but [on the system he described, using a bee house] it is quite superfluous. As timidity may foster a feeling of insecurity, and as the armour of a bee-dress may give confidence to an operator, I shall describe one that appears to me very suitable.

Few early garments or other contrivances survive. Beekeeping museums in the Netherlands have a few, including that in Figure 33.5b, and the one in Figure 34.3a which dates from the early 1800s although its style is much older. It is made of striped linen, and the insert, 19.5 cm in diameter, is of copper wire. The German linen coverall in Figure 33.5d dates from perhaps 1840.

Figure 33.5d Beekeeper's protective coverall from about 1840, at the Bavarian Beekeeping Institute, Erlangen, Germany. The linen garment is kept away from the body by a series of wire rings. The insert at the front is woven, and has an opening for the stem of a pipe smoker.

At some stage cheaper woven black horsehair replaced other materials for the front panel of the veil.

33.6 Protection against stings 1850-1950

33.61 Protective clothing

Dzierzon's *Rationelle Bienenzucht* (1861) showed a 'bee-cap or bee-hood', described in C.N. Abbott's 1882 English translation as follows.

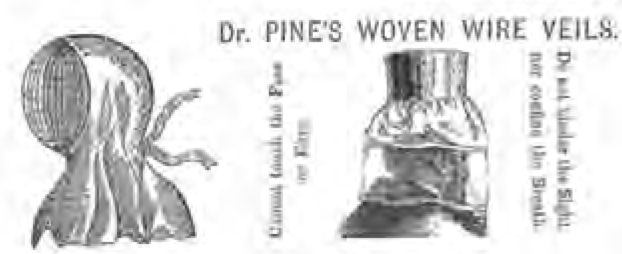


Figure 33.6a German hood and English hat. *left* German bee hood in Dzierzon's *Rationelle Bienenzucht* (1861), which was also published in the English translation (1882). The description is quoted in the text. *right* Advertisement in the 1882 book for 'Dr Pine's woven wire veils' which won 'First Prize for the best Bee Dress', British Bee-keepers' Association, 1879.

> In its usual shape, it is a small oval [fine-mesh] sieve with a bag attached to it of corresponding width, and in use it is put over the head, but it is extremely uncomfortable, and very oppressive in great heat. The form represented here is far more comfortable, in which the place of the sieve is occupied by a wire mask.

Figure 33.6a shows this headgear, and also a hat and veil advertised in the English edition of the book. Dzierzon gave a clear exposition on protective clothing in general, and the wisdom of using it. In Denmark a face mask of metal wire was used until 1870, when it was replaced by 'a more comfortable textile veil' (Andersen, 1934).

In England, Pettigrew (1870) followed Nutt and Bevan in their dislike of protective clothing.

Protection for working with movable-frame hives

Effective use of movable-frame hives devised in 1851 by Langstroth in the USA (Section 40.7) involved the handling of framed combs covered with bees, on many occasions in the active beekeeping season. Beekeepers were thus at greater risk from being stung, and purpose-made protective clothing – especially a veil for the head and face – was increasingly worn. North American beekeepers, the first to practise the new beekeeping, wore hats (not hoods) in everyday life, as did their forebears who came from Britain. So they used a hat and veil for beekeeping, initially with normal outdoor working clothes. Many beekeepers did not wear gloves – some because gloves interfered with the sense of touch, and others because it was regarded as a sign of weakness or timidity.

Langstroth himself proposed a rigid wire-mesh cylinder round the head, with cloth at top and bottom (Figure 33.6b), as a functional design for a head covering. A.I. Root (1877) published illustrations of eight styles of a hat-plus-veil, including one used by

Figure 33.6b North American 'bee-hat' (Langstroth, 1853).

Mrs L. Harrison in Illinois (Figure 53.5b) which was rather similar to Langstroth's. Quinby's 1879 outfit had a hat and a veil 'of mosquito netting, tarlatan or lace', fitted with elastic* at the top 'to be adjusted over the hat crown. ... A piece of coarse-meshed wire cloth of as fine a wire as can be obtained', about 6 x 9 inches [15 x 23 cm], was inserted in front, although 'stout black bobinet lace [was] thought by some to be better for the eyes than the wire cloth'. Finally, 'at a suitable distance from the bottom, attach a narrow tape to tie about the neck'. Many veils of this type are still in use.

In England, Neighbour (1866) said that: 'there is great advantage in having the face and hands covered whilst at work amongst the bees; for when the operator knows he cannot possibly be stung, he can open his hives, take out the combs, gather in his swarms, or take the honey, with all the deliberation of a philosopher.' The bee-dress he described was:

> made of strong *black net*, in shape like an inverted bag, large enough to allow of a gentleman's wide-awake or a lady's hat being worn underneath. The projection of the hat or cap causes the dress to stand off from the face ... An elastic band secures the dress round the waist; the sleeves also, made of durable black calico, are secured at the wrists by a similar method. The hands of the bee-master may be effectually protected with a pair of india-rubber gloves, which should be put on before the dress is fastened round the wrists.

By 1950, except in some countries of Europe and the Mediterranean region where the use of the hood continued, the standard item of protective clothing for frame-hive beekeepers in the world at large was a brimmed hat with a veil hanging from it (Figure

*Elastic made from rubber was invented in England in 1820 and was available in a form suitable for use in clothing after 1836; it was a great asset in securing bee veils.

Figure 33.6c English veil of fine black net worn with a straw hat, widely used since the late 1800s (BBKA, 1884).

33.6c). The veil might be all of black net, or of cotton with an insert of black wire gauze to see through, like veils in Figure 33.7a. The bottom of the veil was secured by strings or some other means, to prevent bees getting inside it. Many beekeepers wore no further special protection, but a coverall (usually white) and gum boots became increasingly common, and if gloves were worn they were gauntleted. Effective zip fasteners, available from the 1930s, simplified the making of bee-tight joins between two parts of an outfit.

In the late 1800s beekeepers in the USA started to produce packages of bees (Section 44.31), and this involved shaking all the bees off combs from many colonies in quick succession. Many of these bees were readily alerted to sting, so very effective protection was needed for the operation, as it was later with Africanized bees (Section 33.7).

33.62 Reduction of stinging by the choice of bees used

In the mid-1800s beekeepers in northern Europe and North America had started to search for bees from other regions that could improve the economic return from their beekeeping. So for the first time beekeepers might have a choice of races of bees to use in their hives. Some races from the south and east of Europe proved easier to handle, and less likely to sting, than bees from the north; see Section 36.51. In Germany, Dzierzon wrote in 1861 that 'the best defence against bee stings is in the introduction of the gentle Italian bees, which sting extremely rarely, and only when they are greatly irritated or pressed'. In 1940 Root and Root reckoned that pure Italians, Caucasians and Carniolans were the most easily handled, stung less, and were 'far less likely to get under one's clothes' than Dutch bees or hybrids. To these authors, hybrids stung more than pure races, and Cyprians, Syrians and Holy Land bees were the worst of all.

33.7 Protective clothing since 1950

After about 1950, the quality and convenience of protective clothing improved in technologically advanced countries, as a result of generally higher standards of ready-made clothes and the availability of new materials, and perhaps also because of market creation through advertising. Better and cheaper zip fasteners allowed the parts of an integral garment to be attached together quickly and securely against bees. The hood came into use again in countries outside continental Europe, starting in England, as a zipped-on part of a professionally made integral coverall. But the hat-plus-veil was less expensive, and was still more common. Velcro fasteners, devised in Switzerland in the early 1960s, were used to fasten lightweight leggings.

Changes in protective clothing were also initiated as a result of the more widespread use of movable-frame hives for tropical African *Apis mellifera*, which stung much more readily than temperate-zone European bees. A few European beekeepers developed their commercial use in tropical Africa (e.g. F.G. Smith, 1960) and, more significantly, in 1956 tropical African bees were taken to Brazil; 'Africanized' bees spread over most of South and Central America by 1986, replacing the previously introduced European bees. Protective clothes were developed, largely in the USA, to enable beekeepers to work in conditions such as those shown in Figure 33.7a. A loose coverall of Ripstop nylon was worn over other clothing, and although this was hot it proved effective against sting penetration. Stings readily penetrated gloves of pigskin, but cowhide was better; goatskin with a gauntlet of Ripstop nylon was best (Collins, 1983). To prevent so many bees flying against the veil that the wearer's vision was obscured, the outside of the black mesh insert was sometimes painted white.

I saw a complete modern protective outfit for an *Apis dorsata* honey collector on display in Delhi in 1980.

Figure 33.7a Protective clothing for movable-frame beekeeping with Africanized bees, 1986 (photo: J.E. Tew). Hats varied in style, but all veils had rigid square-cut inserts of black wire-cloth on four sides, for coolness and to keep bees away from the skin.

33.8 History of the treatment of bee stings

The cause of the pain of a bee sting (see end of Section) was not understood until the early 1900s, but various treatments were applied to alleviate local discomfort from the associated swelling. Some of those recommended in past centuries were probably beneficial in that they cooled the skin. In one of his poems, Nicander of Colophon, a native of Asia Minor who lived about 135 BC, included an indiscriminate list of many herbs as remedies for bites or stings of all venomous creatures.

Fraser (1951a) noted that Roman authors hardly mentioned bee stings, and commented that they 'appeared to have considered it wise to leave the stings to the *mellarius*', the slave who looked after the bees. Cicero said in his Tusculan disputations, 'we cannot endure a bee sting without crying out' (*Ibis* 241), and Pliny that 'mellisophyllum (balm) ... is a most effective remedy for the stings of bees ...' (XXI.86). His other remedies were the application of juice of mallow or ivy, or drinking wine boiled with bay leaves (*Laurus nobilis*). In Spain about AD 1000, Avicenna recommended a decoction of marsh mallow, *Althea officinalis*, with vinegar or wine; an extract of this plant has been commonly used in pharmacy as a soothing agent.

Anatomie universelle (1550) by Ambrose Paré, a famous French surgeon, included a chapter on stinging by bees, wasps, etc., which discussed both symptoms and remedies (Fraser, 1951c). In England, Gerard's *Herball* (1597) recommended mallow, mint, rue, and bay or laurel. T. Hill (1568) quoted some of the Roman authors above, as did Butler (1609) who also gave his own experience.

> ... instantly wipe off the Bee, sting and all, and wash the place with your spittle; so shall you prevent both paine and swelling ... the wound [is] so little, that no Antidote can follow after; and yet I have heard commended for a remedie, the juyce of Houseleeke, of Rue, of Mallowes, of Ivie, of a Marigold leafe, of Holyhock and Vinegar, of Salt and Vinegar, and divers other things. ... Rue drunken with Wine, or rather with Hydromel, or the leaves stamped with honie and Salt, and laid to the wound....

Remnant (1637) repeated most of this and added St John's wort as a remedy.

By the 1800s certain household chemicals were being applied to bee stings. In England, Huish (1815) said that 'the surest method to diminish the effect of the sting, is to extract it immediately, and strike the wound with goulard or laudanum'. Goulard's extract contained subacetate of lead, and laudanum contained opium. Nutt (1832) applied no treatment, but for frailer beekeepers he proposed slices of onion, plantain juice, olive oil, common salt, laudanum, and chalk or whitening. To Golding (1847) 'the most

effectual remedy appears to be ... spirit of hartshorn', a solution of ammonia in alcohol. Quinby (1879) said 'ammonia, soda, or salt and soda mixed, and slightly moistened, are probably as efficient as anything'. Simple cooling agents were also recommended, for instance cool earth or grass (Krünitz, 1774), or cold water applied with wet cloths or a mud plaster (Langstroth, 1853).

Histamine, which is largely responsible for the local reactions to stings, was first studied in the early 1900s, and antihistamine creams were subsequently developed. Riches (1982) detailed treatments based on adrenalin for anaphylactic shock in hypersensitive patients, and also for desensitizing such patients.

34

History of Controlling Bees with Smoke and Other Substances

Most of this Chapter is concerned with the smoker as an appliance constructed to contain smouldering fuel and to allow the smoke to be directed towards honey bees in a hive: European and African *Apis mellifera*, and also *A. cerana* in Asia for which smoke was less needed.

34.1 Effects of smoke on bees

Smoke consists of airborne particles derived from combustion. It repels bees, and also pacifies them because they engorge themselves with honey – which may perhaps be regarded as taking on a full load of fuel for flight to escape from a fire. In Ancient Greece, the author of *Historia animalium* Book IX said that after being smoked bees 'devour the honey most ravenously' (40.623b). Bees engorged with honey are much less likely to sting than hungry, empty bees. In 1968/69 Newton's experiments with a hive of European *A. mellifera* showed that after smoke was applied to bees the number of them imbibing honey rose to a peak between 2 and 10 minutes later, and that during the first 5 minutes very few bees were guarding the hive entrance.

Fuels for a smoker should produce cool smoke and little deposit. Dried dung, decayed wood, grasses or suitable leaves were used, according to what was available. For many centuries, some hive beekeepers also used smoke containing a substance which temporarily narcotized bees (i.e. made them unconscious) and, at a higher concentration, would kill them – such as tobacco and puffball (Sections 34.3, 34.4). Smoke from brimstone (sulphur), much used for killing colonies in skeps before harvesting their honey, was recommended by Thomas Hill in 1568 for driving bees out of a hollow tree and into a hive.

34.2 The earliest smokers

Smoke generally drifts upwards, and honey hunters and collectors might light a smouldering fire of plant material below a nest – especially one of *A. dorsata*. For a nest in a cavity, the source of smoke (a smoker) was usually carried to the nest. A bundle of plant materials might be specially constructed to provide smoke for a long period; I found very good smokers of this type in western Uganda in 1984.

Some known Mesolithic rock paintings of honey collection (Table 10.2B) may show smoke being used, and in one painting in India that may be post-Mesolithic (Figure 10.2c) a person appears to be applying a torch to a comb of *Apis dorsata*. In a rock painting in Zimbabwe (Figure 8.6a) a honey hunter is smoking a colony of tropical *A. mellifera* out of its nest cavity.

Figure 9.3b(C) shows a smoker belonging to a recent Hungarian honey hunter. However, in general a vessel containing smouldering fuel was used only in hive beekeeping. A simple smoker consisted of an open vessel holding fuel such as rotten wood or dried dung, which smouldered slowly even in the presence of air. It might be a general-use container, or one made for the purpose. In the earliest known representation of hive beekeeping, dated to about 2400 BC (Figure 20.3a), an Egyptian beekeeper harvesting honey is holding an object against the opened end of a hive, and although details of it have not survived, it is probably a smoker because an inscription above reads: 'to create a draught, or current of air'. The next known beekeeping scene, also in Egypt (Figure 20.3b), shows an open smoker clearly; an assistant seems to be holding it out of the way – and not blowing on it – while the beekeeper takes a honey comb from one of the hives. Beekeepers also smoked bees in Ancient Greece, and Diodorus Siculus who lived about 80 BC wrote of 'smoking the bees with skilful hand', but we have no direct evidence as to how the smoke was applied.

In Rome, Virgil's directions for taking honey from a hive (*Georgics* IV.228) included: 'in your hand hold forth searching smoke.' Columella (*De re rustica* IX.15.5) described a smoker as an earthenware vessel with handles, shaped like a narrow pot; the beekeeper blew on the fuel in the pot through one

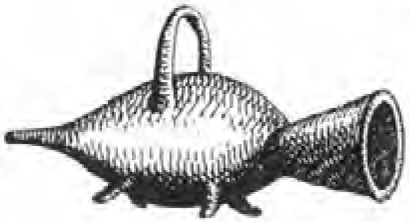


Figure 34.2a Pottery smoker described by della Rocca (1790) and shown in Plate II of his Volume II.

Figure 34.2b Pottery smoker from Algeria, 1974, IBRA Collection B74/34 (photo: I. Ritchie).

(open) end, and the smoke emerged from a small aperture at the other more pointed end. The fuel was either dried dung or *galbanum*, 'mixed with live coals'; *galbanum* is resin from *Ferula galbaniflua*. Columella had a good understanding of the proper use of smoke; it should be applied to the opened back of the hive so that 'the bees move to the front part of their abode, and sometimes outside' (IX.15.6). Hive beekeepers in two of the *Exultet* Rolls from early mediaeval Italy seem to be using drifting smoke. Thomas Hill's 1568 book, compiled from a Latin one by Pictorius in Germany in 1563, gave the following instructions for making bees leave their combs in a skep.

> First, stoppe the holes of the hives, that the Bees passe not forth, with grasse or some other hearbe, after that put under fine linnen rags or straw, making a little smoke with the same, which smoke so flying up causeth the bees after to breake, and leave their clustring together.

On Syros in the Aegean, della Rocca (1790) used the smoker shown in Figure 34.2a in the way decribed by Columella, but if he wanted to smoke the bees heavily he blew through the small opening and directed smoke on to them from the large opening. He mentioned two details: Parisian potters called the vessel a tortoise, and a similar smoker with many small holes in the top part was also used. Such a smoker, shaped like a shoe and traditional in Corsica, was illustrated by Musée National des Arts (1981).

In the Mediterranean area pottery smokers were widely used in early times, and up to the present day. Figure 34.2b shows one from North Africa which is rather similar to that in Figure 9.3b(C). Many were like della Rocca's in principle, and incorporated a handle to use when the pot became too hot to hold. In Crete, six or seven slightly different styles were still made in 1985, and Figure 34.2c shows one of them as it would be held when opening a top-bar hive

Figure 34.2c Pottery smoker from Crete, held ready to use on a *vraski*, top-bar hive, 1979 (photo: E. Crane). The style is similar to that in Figure 34.2a.

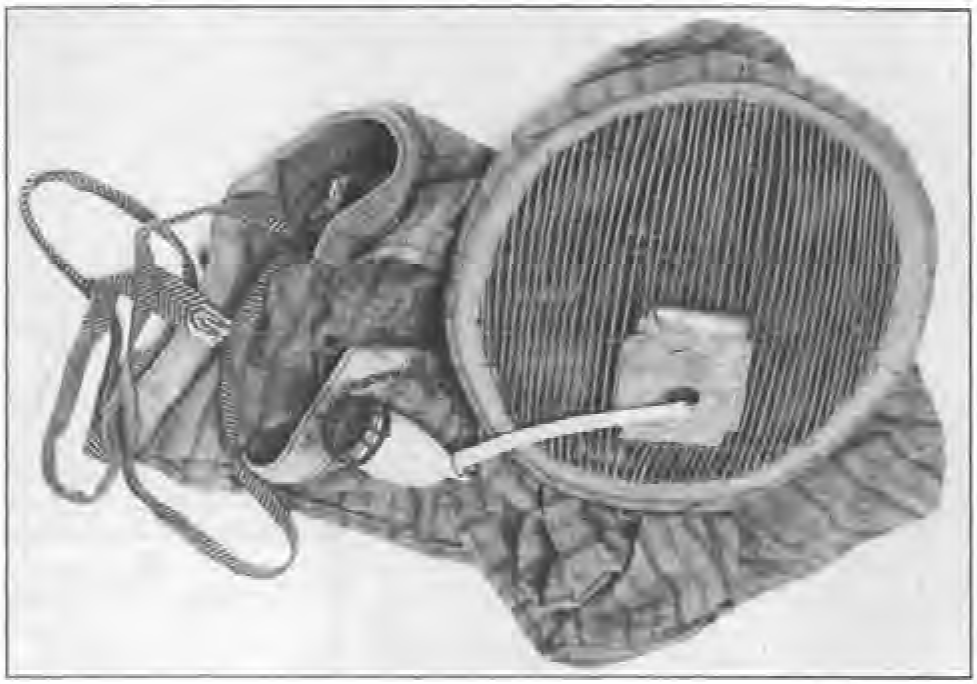


Figure 34.3a 'Goudse' clay pipe smoker (14.5 cm long) with a lid of iron wire, and a bee veil whose wire insert has a hole for it (Nederlands Openluchtmuseum, Arnhem, AA 88197). Veil from Zuidlaren, Drenthe, early 1800s

to inspect the bees in it. Pottery smokers were used in Aegean islands (Miller, 1978), and Monarco (1983) illustrated an upright version from Lombardy. They were also known in regions farther north, for instance in Hungary and Poland (Wolski, 1960; Szacki, 1980).

About 1655 in England, John Evelyn gave detailed instructions for smoking bees in a hive such as a skep.

> When you are minded to look into a hive first have in readiness dried cowdung, which break over a chafin[g] dish of coals and let the smoke fume on your face and hands; then take off the hive gently and hold it a little time over the smoke, after which you may turn up the hive and view it as you please; for the bees will all creep up toward the top of the hive and not mind to molest you.

In Menorca, a little bronze cauldron was used as a smoker in recent times, and probably earlier; it was filled with red-hot charcoal and sprinkled with dead leaves (Stretton, 1980), and the beekeeper blew across the open mouth to direct smoke into the back of the hive.

34.3 Pipe-smokers and the use of tobacco

In the late 1500s tobacco was introduced to England from North America, together with clay pipes for smoking it. Beekeepers probably noticed that smoking a pipe prevented bees flying near the face; in fact the tobacco smoke narcotizes them.

From the early 1700s, purpose-made beekeeper's pipe-smokers of metal and wood – which left both hands free – were produced in many countries of Europe, and Figures 34.3a and 33.5b show examples. They seem to have been used especially in regions where beekeeping operations were done in a bee house (Figure 32.3d). Pipe-smokers were common in Germany, Austria, German-speaking Switzerland, parts of Czechoslovakia and Poland, Alsace now in France, and the Netherlands. In Krünitz's 1774 engraving of tree beekeeping activities (Figure 16.2b), the beekeeper on the left is smoking a pipe and letting the smoke drift up in front of his face. According to Bevan in England (1838), 'with those accustomed to smoke, nothing more is necessary than a cigar or pipe of tobacco, so that the operator may be able to direct a few whiffs into the hive which he is desirous to examine or remove'. Figure 34.4b(4), from 1842, shows a clay pipe smoker fitted with a lid.

Frequent use of a pipe-smoker over many years damaged the teeth, and in Germany Dathe (1870) devised a pipe that hung from a cord round the neck and need not be held continuously in the mouth. Where pipe-smokers were common, bee veils were made with a small opening to accommodate the stem of the pipe, as in Figure 34.3a. In some areas, pipe-

Figure 34.4a The first known record of the use of bellows to produce smoke when working with bees (Hervigius, 1649).

smokers were used until well after 1950, but as beekeepers changed from keeping their hives in a bee house to siting them in the open – and to maintaining larger colonies – they changed to the commonly used bellows smoker (Section 34.4).

Pipe-smokers were used to a minor extent in England in the 1880s, and Cheshire (1874) designed one not held in the mouth; the bowl of a smoker's ordinary briar pipe was extended with a rubber tube closed at the other end by a cork; the tube was squeezed intermittently, which drove 'gentle little puffs' of smoke out of the stem of the pipe. This smoker cannot have produced much smoke, but in 1874 it won a medal at the first Crystal Palace Show near London (British Bee Journal, 1874a). IBRA has examples of Griffith's Patent Smoker (B52/27, B54/14) produced at Weobley in Herefordshire: a tinned iron pipe with a stem nearly 50 cm long and a small bowl like that of a clay pipe.

Many beekeepers in North America smoked tobacco, and they puffed mouthfuls of the smoke directly on to the bees. Pipe smokers were not used, but Alley (1876) devised a smoker in which the smoke was blown through an extended tube, 'very light and held in the teeth'.

34.4 Bellows smokers and the use of puffball

The burning of giant puffball (a fungus, *Langermannia gigantea*, Table 8.6A) was referred to in the 1597 English edition of Gerard's *The herball* (page 1385): '... fusse bals with which in some places of England they use to kill or smolder their Bees, when they woulde drive the Hives, and bereave the poore Bees of their meate, houses, and lives.' The book consisted largely of a translation of Dodoens' *Pemptades*, but this passage is not in the Latin original and must be one of Gerard's own comments (IBRA, 1979). The use of puffball was promoted in France by Montfort (1646) and in the Netherlands by Groen (1669).

The 1649 woodcut in Figure 34.4a shows a beekeeper using bellows to produce smoke during an attempt to take a swarm of bees. In 1771 Janscha in Austria described the use of a smoker when manipulating hives of bees, in which the fuel was in a vessel of sheet iron or clay that fitted on the nozzle of bellows. By the 1700s and 1800s, a number of beekeepers in northern Europe believed it was both wrong and unnecessary to kill bees in order to take their honey, and bellows smokers were developed largely for the controlled burning of puffball to narcotize the bees without killing them. One of the mottoes of Cotton in England (1842) was 'Never kill a bee', and he described his use of smoker no. 2 (Figure 34.4b) on bees in a skep.

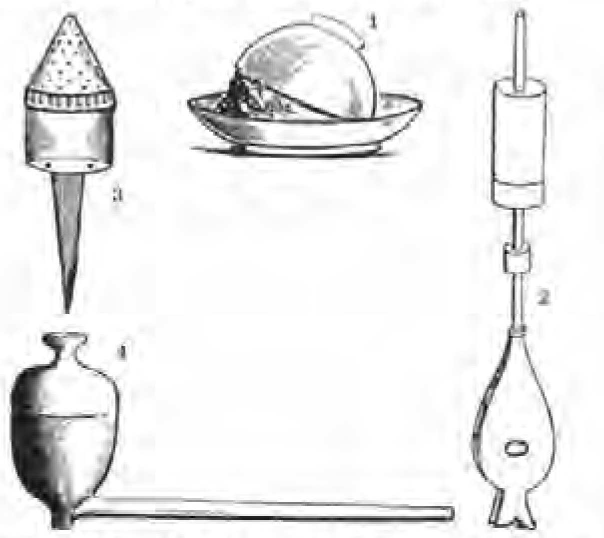


Figure 34.4b Cotton's 1842 drawing to show the state of the art of smoking bees. 1 Cup and saucer with slow-burning pieces of puffball (a stupefier), to be placed beneath a skep; 2 Bellows smoker (fumigator), described in the text. 3 Tin firebox smoker (shown without bellows). 4 Clay pipe with cover, in which tobacco was smoked.

> Get a little tin box fitted to the nose of your bellows, having a sort of spout coming from it, which fits the door of your Bee-hive. Take a piece of fungus twice the size of a hen's egg, light it, and when it burns freely, put it into the box; fit it into your bellows, and blow the smoke into your Hive. Stop that part of the door up with wet clay which the tin spout does not fill, that none of the smoke may get out. The Bees at first will make a great buzzing; in about five minutes all will be as still as death. Lift the Hive gently off, and turn those Bees which have fallen on to the bottom board into a large white dish. ... The fungus does them no harm ... as they get well in twenty minutes.

Further instructions followed, on removing the remaining bees from the combs, finding the queen and 'putting her softly to one side', then cutting the combs out carefully one by one. He united the bees with those of another colony whose combs were not taken.

Nutt was a like-minded English author, and in *Humanity to honeybees* (1832) he described how he 'fumigated' a colony with smouldering puffball when he needed to examine it. Bevan (1838) wrote that, for non-smokers, 'recourse may be had to a fumigating box attached to the nozzle of a pair of bellows, placed in the hands of an assistant'. He showed a fumigating box rather similar to no. 3 in Figure 34.4b, except that there was only one hole in the nozzle. Figure 34.4c shows the use of a bellows smoker in France.

Smoke from puffball was also applied to bees without bellows. In England two types of fumigator were developed in the early 1800s. A 'stupefier' was a shallow vessel with a perforated lid, or a cup and saucer (no. 1 in Figure 34.4b), which was suspended under a skep to narcotize a whole colony, or when uniting two colonies. When using a 'fumigator' (no. 2), bellows blew air through a tin cylinder containing the fuel and through a narrow tube on to the bees.

An article in the 1874 *British Bee Journal*, entitled 'Ligurianizing for ladies', described how the use of smoke from pieces of puffball made it possible to requeen a skep colony and so to replace native dark bees by Italians.

Figure 34.4c Using a smoker similar to 2 in Figure 34.4b, to move bees from one skep to another, in France (Hamet, 1859).

34.5 Smokers developed for use with movable-frame hives

It now seems extraordinary that in the early years of movable-frame hives in the USA, from 1851 onwards, beekeepers worked without any appropriate large-volume smoker. As late as the 1865 edition, Langstroth's book on movable-frame beekeeping suggested blowing smoke gently on to bees from a piece of burning rotten wood. Even the type of bellows smoker used in Europe since 1771, which gave a relatively small stream of smoke, seems to have been unknown in the USA where so many other developments were made.

In 1873 Moses Quinby produced the bellows smoker in Figure 34.5a which could be operated with one hand. The smoke was expelled from the nozzle by a direct draught from bellows *at the side*, which were connected by a tube to the fuel box. In 1877 Bingham advertised a smoker improved in several ways (Pellett, 1938); he retained Quinby's position of the bellows, which he placed with the wider end at

Figure 34.5a Quinby's 1873 smoker (Quinby, 1879). See text.

the top. He used a larger fuel box, and inserted a hole near the bottom of it (opposite the hole in the bellows) so that, even when the bellows were not being operated, enough air was provided to keep the smoker alight.

Both Quinby's and Bingham's were 'hot-blast' smokers, in that air blown from the nozzle had passed through the smouldering fuel. 'Cold-blast' smokers were introduced by Norman Clark and J.G. Carey in 1879, followed by J.E. Crane in 1890. In these, a tube conducted air from the bellows to a point ahead of the smouldering fuel, so that the smoke was cool when it emerged. They did not produce as much smoke as hot-blast smokers and were less widely used.

Morse (1954) described a number of early smokers. Bingham's design came into worldwide use, and has been little changed except that models were made larger and – for working with Africanized bees – very much larger.

34.6 Other specifically active substances

A fuel tried as an alternative to giant puffball was nitrous oxide, produced by heating nitrates; Cotton (1842) said that 'linen rags soaked in nitre [potassium nitrate] will do, when the fungus cannot be had'. In 1950 Gontarski in Germany found that colonies of bees were temporarily narcotized if they were smoked with fuel to which ammonium nitrate had been added, and he assumed that this was due to the production of nitrous oxide. However, Simpson (1954) showed that fumes from smoker fuel which incorporated ammonium nitrate contained either hydrogen cyanide or cyanogen, which are toxic. He concluded that although a single treatment of a colony with ammonium nitrate fumes was unlikely to be harmful, it changed the bees' foraging behaviour to some extent. In Zimbabwe, Papadopoulo (1966) reported that it damaged colonies of tropical African bees in several ways.

Table 8.6A lists various plant materials used by honey hunters in tropical Africa for smoking bees, and Table 8.6B a number of other plant materials which honey hunters and collectors used without burning, to pacify or repel temperate-zone and tropical honey bees. Some of them, especially lemon grass and balm, were also used by hive beekeepers. Section 43.4 refers to chemical substances used from the late 1800s to repel bees, and so to remove them from honey combs in movable-frame hives.

35

History of Migratory Beekeeping

35.1 Why hives were migrated

In the north temperate zone, plants flower for only part of the year, and any one plant species for no more than a few weeks. To extend the honey-producing period, beekeepers in Europe traditionally took advantage of flowering in nearby areas by migrating their hives. Areas at different altitudes or latitudes provided pasture at different seasons, and those with different rainfall or soil supported different plant species. Migration of hives was sometimes known as transhumance or pastoral beekeeping; these terms are derived from the seasonal moving of livestock away from an area where pasture was failing, to another where it was becoming available (*humus* = ground).

All Sections in this Chapter relate to *A. mellifera*; little migration seems to have been done with *A. cerana*, and none with stingless bees.

Practices of migratory beekeeping changed little until the late 1800s and early 1900s, when mechanical road transport was becoming reliable and movable-frame hives were in common use. By then, farmers were starting to grow monocultures of native and non-native crop plants, and beekeepers increased their honey production by moving hives on to some of them. Later, hives of bees were increasingly migrated to crops to pollinate them (Section 45.5). In Australia, honey production was largely based on migration to native *Eucalyptus* species; if brood rearing dwindled because colonies were working a species that did not produce adequate pollen, the bees might be migrated to a good pollen source instead of feeding pollen to them. But, through the centuries, most migration was undertaken to get an extra crop of honey.

35.2 Transport of traditional hives on migration

Columella (IX.14.20) set out the general principles of transporting hives, quoting Celsus:

> He gives instructions to examine the hives carefully before transferring them and to remove honey combs which are old and wormy and falling to pieces, keeping only a few, and these the best, so that as many combs as possible may be made at the same time from the better flowers. He also says that the hives which anyone wishes to transfer should only be moved at night and without being shaken.

Beekeepers usually moved hives by night because temperatures were then lower, and there was less chance of heat generated by the confined bees melting combs and killing the bees themselves.

Columella (IX.14.19) also quoted Celsus as saying that in Greece migratory beekeeping was 'the practice both in the regions of Achaia, where the bees are transferred to pastures in Attica, and in Euboea, ... and likewise in Sicily, when they are moved from the other parts of the island to Hybla'. Records of specific migrations undertaken in the Ancient World are quoted later.

Hives most suitable for migration were light in weight, robust, and easy to close so that bees could not escape. To prepare them for transport, they were closed after sunset when all the bees were inside, in a way that gave enough ventilation to prevent the bees becoming overheated. With a straw skep, Butler (1609) explained that beekeepers commonly 'make no more adoe but after sun-set when the Bees are at rest, to lift up the stall [skep] and set it upon a mantle spread on the ground, and so to binde it up, leaving the Bees upon the stoole [hive stand] ... behind'. He also described a more careful method which ensured that no bees still out of the hive were left behind.

Migratory beekeepers transported their hives in ways used for other goods: they carried them, or loaded them on to pack animals or carts. Where new pasture was accessible by navigable water, hives could travel by boat. By the late 1800s railway trains were used, and during the 1900s road vehicles of many types and sizes. Air travel has usually been too expensive for migratory work.

35.21 Carriage by pack animals and by beekeepers

The earliest surviving reference to migratory beekeeping is a petition from beekeepers to Zenon, a Greek official in Fayum, Lower Egypt. The papyrus, dated to about 250 BC (Edgar, 1928), reads as follows.

> To Zenon greeting from the Beekeepers of the Arsinoite nome. You wrote about the donkeys, that they were to come to Philadelphia and work ten days. But it is now eighteen days that they have been working and the hives have been kept in the fields, and it is time to bring them home and we have no donkeys to carry them back. Now it is no small impost that we pay the King. Unless the donkeys are sent at once, the result will be that the hives will be ruined and the impost lost. Already the peasants are warning us, saying, 'We are going to release the water and burn the brushwood, so unless you remove them you will lose them.' We beg you then, if it please you, to send us our donkeys, in order that we may remove them. And after removing them we will come back with the donkeys when you need them. May you prosper!

The use of pack animals – mules, donkeys and camels, and less commonly horses – continued through the centuries. Pliny's passage about boat transport quoted below also said that 'in Spain they convey hives on mules for a similar purpose'. In Crete, flared cylindrical pottery hives were carried on mules, at any rate in recent years (Ruttner, 1979b), but donkeys were in general use there from the 2000s BC, and in Greece from the last centuries BC (Mason, 1984). In recent times, the usual load in Pakistan was 3 movable-frame hives on a mule and 12 on a camel (K. Khan, 1993). Marchenay (1979) published an 1899 photograph of a camel carrying 16 or more modern hives between Ramlech and Jaffa in Palestine. In England hives were sometimes loaded on to horses (Isaac, 1803), but Walter McClatchey (1990) described his grandfather's experience in the USA in 1858, when two hives in a wagon train split open: one of the horses ran off and was lost, but the mules could be handled and controlled.

The beekeeper himself could carry one or more hives. In Crete, a handle was devised to sling one of the pottery hives mentioned above from the beekeeper's shoulder. In the Netherlands and some Asian countries, a hive was attached to each end of a carrying pole supported on a shoulder. Or several hives could be slung from a pole if a man supported each end; Butler (1609) in England was very careful about carrying hives in this or any other way.

> The best way to carrie your stall is upon a cowl-staffe [carrying pole] between two. (If you have many to remove; two lustie fellowes may beare two or three of them at once; but let them all be fast bound together.) If it be light, one may carry it in his hand. But, howsoever, be sure that it hang perpendicularly for feare of breaking the Combes, especially ... when the wax is soft.

Another method was to use two poles with a carrying cloth or cross-rails stretched between them. The German chapbook *Till Eulenspiegel*, published in 1515, shows two men carrying a coiled-straw skep on such a platform, and in Figure 26.3a two poles are being used in Denmark in 1649. In England, Isaac (1803) described:

> an elastic bier, formed of two round dried aller [alder] poles, seven feet long, united in the middle by a doubled canvas cloth, at twenty-one inches asunder, and long enough to receive three hives ... The poles are supported by web-strings from the shoulders of the carriers, and held by their hands, like a sedan chair. They can carry three swarms away, but on account of the increase of weight, the carriers can bring home but two at a time.

A special frame enabled one man to carry several hives in mountain country (Figure 35.2a). As late as about 1900 in the Italian Alps, women of Bagnara, Calabria, carried hives on their heads to migratory apiaries, a small group travelling on foot by night (Marchenay, 1979). Movable-frame hives were transported in the same way in Croatia and elsewhere. In Kashmir, modern hives were sometimes taken as head loads from a truck to sites inaccessible by road (F.A. Shah, 1975).

35.22 Carriage by boat

Celsus was quoted by Columella (IX.14.19) as saying that in Greece 'bees are transferred to pastures ... in the islands of the Cyclades, when they are transferred from other islands to Skyros'. Such transfers must have been made by boat. Pliny (AD 23-79) gave the following description of moving hives from the village of Hostilia along the River Po, using a boat as a mobile apiary (XXI.43.73).

Figure 35.2a Slovene beekeeper carrying four horizontal wooden hives on a back-frame (Beekeeping Museum, Radovljica, Slovenia; photo: P. Marchenay).

> When food for the bees is lacking in the immediate neighbourhood, the inhabitants put their hives in boats and take them by night five miles upstream. The bees emerge at dawn, feed and return every day to the boats. They change the position of the boats until they sink low in the water under the weight and it is realized that the hives are full. Then the boats are brought back and the honey harvested.

I have been unable to confirm references to migratory beekeeping by boat on the Nile in Ancient Egypt, but it was described by Maillet in 1740 and may have been customary earlier. In October, beekeepers from different villages in Upper Egypt put an ownership mark on their (horizontal) hives and loaded them on to a large boat; this was floated downstream, keeping pace with the flowering season which was initiated by the rising level of the river due to melt-water from snow near its source. The boat was moored at places with many flowers, and by February it reached the delta, where the hives were placed on land sites for the flowering season there. The honey was sold, probably in Cairo, and the boat with the hives was then sailed home upstream, aided by a north wind. Beekeepers paid the boatman according to the number of their hives on the boat. In May 1761, 20 boats were seen in Damietta at the mouth of the main eastern branch of the Nile, loaded with around 4000 hives. In della Rocca's time (1790) Greek beekeepers migrated hives along the coast of Asia Minor.

Zeghers (1780) mentioned transport by boat and by road in Belgium, and said that on very hot nights cold water was sprinkled on hives to cool them. Marchenay (1979) referred to migration on boats in China and Japan, but the date was not indicated. The boat carried a mark on the hull to show the limit of submersion when the hives were full of honey, and the voyage was then terminated.

Carriage of movable-frame hives by boat

Land transport developed rapidly after the 1850s when movable-frame hives were introduced, but migration by boat continued. Pellett's 1938 account of migratory beekeeping in the USA started in the 1870s, when Perrine bought a steamboat and auxiliary barges in Louisiana. He planned to carry from 1000 to 2000 hives up the Mississippi river, harvesting honey on the way, but seems to have done no advance prospecting for honey flows along the river banks. The first trip was to have covered the 2000 miles (3200 km) to St Paul in Minnesota, but the undertaking collapsed at an early stage owing to accidents, machinery breakdowns, yellow fever hazards and other troubles. Poppleton (1898) in Florida was more successful; he moved single-storey hives on a smaller gasoline (petrol) launch along the Indian River, over distances up to 160 km, finding different sites where plants were flowering and the hives could profitably be offloaded.

Up to the late 1900s Romanian beekeepers moved thousands of hives by boat along waterways in the Danube delta, to utilize the prolific flows from mint and other wild flowers, and at least one boat was used for the purpose on French canals (Poissonnier & Forestier, 1995).

35.23 Carriage by unmechanized land vehicles

Where land routes were passable by a cart, this was the most usual vehicle for transporting hives. In 1555 Olaus Magnus Gothus gave advice on moving hives of bees after purchase.

> They are transported at night on people's backs to distant places with the hives closed up; or

Figure 35.2b Cart carrying hives in northern Europe, probably Flanders (Olaus Magnus, 1555).

Figure 35.2d Drawing 'La gardeuse des abeilles' by Felicien Rops (1833-1898), San Remo. The shaded hand cart probably contains 6 skeps.

> better in carts, where the terrain is marshy or flat, since 15 or 20 hives at a time can be put on one cart, and that quite comfortably. This is the usage in Brabant and Flanders when the hives are taken to pasture at different times in the summer for nourishment. ... Hives cannot be kept close around the master's house wall, nor should they be, ... since in a meagre territory the food supply will be quite insufficient for bees of infinite number. (Translation by Frances Minns)

Figure 35.2b shows a four-wheeled cart in which 15 skeps are visible, and also flying bees – in spite of the text above.

A book by Caille (1697?) in France included a chapter on the transport of skeps of bees on carts. Long thin sticks were fixed across inside the skeps to anchor the combs. After sunset, each skep was wrapped in a cloth and made bee-tight, then placed on its side – presumably with combs vertical – to allow ventilation through the cloth, and it travelled in this position during the night. If the journey was not finished by daybreak, skeps were offloaded so that the bees could forage during the day, then closed up to continue the journey during the following night. Beekeepers migrating hives to Gâtinais for the sainfoin flow placed them with the combs parallel to the cart axles 'so that the bees were not shaken'. They travelled in unlit wagons to prevent any light disturbing the bees (Marchenay, 1979). Both T. Wildman (1768) and Marchenay (1979) quoted details from an unidentified source about the use in France of carts holding 30-48 hives. The 1775 engraving of Janscha's bee wagon (Figure 35.2c) was published in Vienna.

Figure 35.2c Horse-drawn wagon for moving horizontal box hives (Janscha, 1775).

In England, I have spoken with people who remembered horse-drawn carts bringing skeps of bees to heather sites mentioned on p. 352.

A few hives were sometimes moved quite short distances to fresh forage. Jacobs and Plettenburg (1978) illustrated a wooden wheelbarrow in a Dutch museum, loaded with ten skeps prepared for migration. The hives in the Flemish drawing in Figure 35.2d cannot have been moved very far.

35.3 Migratory apiaries

The migratory apiary was likely to be a simpler version of a beekeeper's permanent apiary (Chapter 32). Lightly constructed hives normally kept in a covered building had to be protected adequately in a migratory apiary, or the transport vehicle might serve as a mobile apiary (p. 352). Risks associated with migratory beekeeping included infection or infestation from diseased or parasitized colonies at the migratory site. Theft of hives was widely punishable, and

Figure 35.3a Migratory apiary east of Peshawar, NWFP, Pakistan, 1993 (photo: E. Crane).

Olaus Magnus (1555) commented that in Brabant and Flanders the hives 'are stood around there in very great numbers without guardians. A very heavy penalty is imposed on anyone who despoils public property of this sort. And although a man may not be convictable by witnesses, he very easily betrays himself by the sale of the product that does not belong to him.'

In Austria, Empress Maria Theresa encouraged migratory beekeeping, and around 1760 she enacted a law forbidding any prohibition of 'temporary apiaries'. In some countries the beekeeper lived in a tent near his hives (Figure 35.3a), at any rate in the 1900s, and honey from movable-frame hives was usually extracted at the apiary camp.

The migratory apiary in Figure 39.3c was in Crete. The one in Figure 35.3b was in an area of Turkey with a prolific honeydew flow, to which up to 100,000 hives were still taken in 1985; a beekeeper would leave an old hive at the site he used, to stake his claim to it for the next year, and this was probably a long-standing custom.

Figure 35.3c shows a spectacular migratory apiary in Morocco, at the western end of the Atlas Mountains (Haccour, 1961). It could house 2800-3000 hives, which were brought from lower country

Figure 35.3b Migratory apiary of several hundred hives working the honeydew flow from *Pinus halepensis*, Mugla province, south-west Turkey, 1970s (photo: E. Öder).

Figure 35.3c Complex of shelters with 4 to 5 shelves, built as a migratory apiary by Berber beekeepers about 1850, Tinzerki, Morocco, 1961 (photo: P. Haccour).

to take advantage of the nectar flow from mountain flowers. In 1961 it contained only a few hundred horizontal hives, of woven reeds coated with cow dung.

Some of the apiaries enclosed by high walls on mountain slopes in Spain and France (for instance in Figures 32.5b and 32.5c) may have been migratory sites. But although substantial vestiges of such past migratory apiaries may still be found, few can be closely dated.

Heather apiaries

Large areas of north-west Europe with acid soil were covered with ling heather (*Calluna vulgaris*) which bloomed in August/September – later than most other flowers – and could extend the bees' foraging season by one or two months. Many heather areas probably provided little or no bee forage earlier in the year and could not support colonies permanently.

The fact that the Ancient Laws of Wales (Section 27.52) set a monetary value even on late swarms suggests that bees were able to store the late heather honey, but the laws do not mention migration. The first record in Britain may be that by T. Wildman (1768), who concluded his chapter *On shifting the abodes of bees*: 'If there is heath at a convenient distance, the hives being carried thither, would considerably lengthen out the season of collecting honey ….' Bonner in Scotland also referred to heather in 1795.

In England, Isaac (1803) in Devonshire had learned the value of moving hives on to the heather from as little as a mile away.

> About mid-July, carry your poor swarms into or near the heath, as well as stocks that have swarmed, but are found light; and, if the weather be mild, or a little dry in August, they will soon fill the cottage-hive, out of which you may take at Michaelmas, when you bring them home, as much as to reduce the weight of it to twenty-four pounds, provided you take out no brood. I have proved this by repeated trials.

Whitehead's *Bees to the heather* (1954) discussed many aspects of the subject.

On various hillsides on the North Yorkshire moors in the 1950s I found several hundred flat stones in rows, which had served as skep stands during the heather flow (Walker, 1987). In 1976 I was shown probable vestiges of early migratory apiaries for heather in the New Forest: small areas enclosed in earth banks, marked on early Ordnance Survey maps as 'bee gardens', or still known as 'bee beds' (Crane, 1983a).

The transport vehicle as a mobile apiary

Carts and, later, trailers attached to mechanical vehicles were sometimes used as mobile apiaries. Hives were loaded with flight entrances on the outside, and left in place at the migratory site. The 1555 cart in Figure 35.2b may possibly have been used in this way, and that in Figure 35.2d certainly was. Figure 35.3d shows a larger, more recent migratory bee house.

35.4 Use of mechanized rail and road transport

Beekeepers took advantage of improved transport systems when these became economic for migrating hives: steam railways in the 1800s, and petrol driven road vehicles around 1900.

Rail transport was available in many areas by the time movable-frame hives were introduced. The first beekeeper to use it for migrating hives was probably Harbison in California, USA. After his home honey flow had ended in 1876, he moved hives to a higher area 100 km away for the late wild flowers (Pellett, 1938). A Californian beekeeper known as Migratory Graham moved whole carlots (wagon loads) of hives by rail, as many as 161 in 1918. From 1903, the Belgian government encouraged migratory beekeeping by running special trains to take hives to the heather, and providing and supervising migratory sites, all at reduced rates (Marchenay, 1979). Hives of bees were, and still are, moved by rail in China. But in many places the costs of rail freight, together with transport from the train to the migratory apiary by horse and cart, and the loading and unloading of hives, proved too high.

By 1918 it was becoming possible to use mechanized road vehicles, which enabled the beekeeper to control the timing of the journey by day or night, and he could also monitor his hives on the journey. Once roads and road vehicles were sufficiently developed, they were almost always used for moving hives. Together with mobile extracting plants, they revolutionized migratory beekeeping in some regions, and greatly increased the distance over which hives could be moved. Much of the beekeeping in Australia became based on long-distance hive transport between stands of different *Eucalyptus* species as each came into flower once every 1, 2 or 4 years. In the late 1940s Australian honey production was doubled within five years. An article in *Empire Producer* (1950) described an unusually long migration during which two beekeepers took 1600 hives in a convoy of trucks from the east to the west of the continent (over 3000 km), to work flows from various *Eucalyptus* species. Kylie Tennant's novel *The honey flow* (1956) was written after she had spent three years on migration with beekeepers in New South Wales and Queensland. See Figure 41.5b.

In the USA, large-scale beekeeping came to depend more and more on migration, and various seasonal routes were developed from one flowering crop to another. A lively account of migratory beekeeping in California, mostly for alfalfa pollination, was published by Whitcombe and Douglas in 1955. Annual migration routes followed the developing seasons in some other countries whose land extended over a wide range of latitude or altitude; in Japan the route included three islands in a south to north sequence (Sakai & Matsuka, 1982):

Kyushu	April	rape, Chinese milk vetch
north Honshu	May	apple, black locust, horse chestnut
Hokkaido	July	black locust, limes, clover.

By the 1960s migratory beekeepers in Australia and North America realized that bees would remain inside hives with open entrances, by day as well as by night, so long as the engine of the vehicle was running; the bees responded to the vibration by clustering inside the top of their hive.

Likely hazards during transport were overheating or escape of bees, and the shifting of a whole load of hives. 'Bee nets' were therefore developed to envelop the whole cargo.

Figure 35.3d Trailer built as a migratory bee house, Czechoslovakia, 1974 (photo: J. Whiston).

36

Transport and Spread of Honey Bees around the World

36.1 The range of destinations, and how bees were transported

36.11 Early transport of bees

The first transports were probably achieved within Asia, and started in Ancient times. The earliest known record is from the mid-700s BC (Figure 21.1a), when the Assyrian ruler Shamash-res-usur brought 'bees which gather honey' from mountains in the north to the land of Suhu on the middle Euphrates, where he was Governor. These bees would have been *Apis mellifera*, probably *meda*.

Writing about eastern Iran, Gassparian (1977) regarded it as certain 'that *Apis cerana* was brought to Iran from Pakistan by man. ... The history of beekeeping in Baluchistan [the arid area between the lower Indus valley and Iran] goes back some centuries; ... some Baluchistan farmers brought their bee hives from Pakistan.' At the Pakistan Museum of Natural History in Islamabad, Qatabud-Din (1989) confirmed that at certain seasons nomads traditionally crossed Baluchistan with their livestock, travelling along the coast and probably also inland. They could have taken colonies of *A. cerana* in hives (water pots) on their pack animals, letting the bees out to forage when they camped.

Bees could also have been taken to Oman across the Persian Gulf by boat in Antiquity or later, and according to Whitcombe (1984a) *Apis florea* had already arrived there across the narrow Strait of Hormuz about 20,000 BC, when the sea level was lower than at present. *A. m. jemenitica* was taken to Oman from Yemen about AD 1700 (Whitcombe) or later (Dutton *et al.*, 1981).

36.12 Transport to distant parts of the world

Honey bees evolved in the tropics of the Old World (Table 3.1A) and spread from there to the north temperate zone in Europe and Asia. The great dispersal of honey bees by man occurred after 1600, when various races and subspecies of *A. mellifera* in Europe and the Mediterranean region were transported to many other parts of the world. European honey bees were first taken outside the Old World by colonists from Britain and France in the 1600s, and by 1990 these honey bees had been spread over an additional 60% of the earth's land area. Other honey bee species (from Asia east of Persia) were much less transported.

Tables in the Chapter include, where feasible, the date of the first introduction of exotic (non-native) hive bees (*Apis*) and their place of origin and, in addition, the date of introduction of movable-frame hives and of *Varroa jacobsoni*. In temperate climates European *A. mellifera* generally survived well, produced many swarms, and spread rapidly where swarms found nest sites, usually in hollow trees. Chapters 12, 31 and 41 discuss man's use of this bee in the new regions, in natural nests and in hives. The availability of air travel in the late 1900s increased the transport of bees and, with them, of infectious bee diseases, parasitic mites and undesirable genetic characters (Section 36.9).

36.13 Transport of honey bee colonies by sea

Until the mid-1900s honey bees could be transported from one land mass to another only by sea. A voyage by sail across the Atlantic lasted up to 6-8 weeks, and one from Europe to Australia up to six months, partly in the tropics. Propellor-driven ships (which crossed the Atlantic in 14 days) were not operated until 1845. The earliest records describing how colonies of bees were kept alive are from the 1800s. In 1805, when Gregory Blaxland sailed from England to Australia on the *William Pitt*, he applied for cargo space for 'a swarm of bees in cabin, with wire cage over hive' (Weatherhead, 1986), but it is not known whether he did in fact take any bees.

Bees starting their voyage in autumn would be physiologically in a 'winter' condition and, if confined, able to retain their faeces; Barrett (1995) suggested that since north European bees were acclimatized in the course of evolution to long winter

confinement, they would travel better than others. Cooling the bees on the voyage could help by reducing their metabolic rate. In 1842 Cotton published his method for a five months' voyage from England to New Zealand, starting in November. He used ice* to cool the bees. An old hogshead, 'fresh coopered and the joints properly fitted' was lined throughout with a coating of thick felt. A wooden platform supported four straw skeps, 'securely tied, each in a square cloth of dairy canvass' and with a ventilation tube; dry cinders were packed round them. The bottom part was filled with ice (Figure 36.1a,A) from which the melt water was drawn off and measured every day, to 'know how much I have left. ... I shall try to keep one or two stocks cool by means of evaporation [Figure 36.1a,B]. ... The Hive is placed on a board resting on springs, that the motion of the ship may not disturb the Bees. Another I have suspended on gimbals, by the aid of which it will always remain quite upright. A wall of water entirely surrounds the Hive. Fresh water is perpetually running into the double case in which the Hive is placed, from the ship's cistern.' Section 36.32 relates the fate of these bees.

In the early 1840s Neighbour (1865) sent 'a Nutt's Hive stocked with bees to New Zealand. We then adopted the plan of fixing the hive in a meat safe, so that the bees could fly about a little, and also cleanse the hive of their dead.' He did not say how the bees fared.

Little information is available about the type of hive used for transport, but straw skeps were most commonly mentioned; hives with movable frames were not used in Europe until the 1860s. Loudon's *Gardener's Magazine* for December 1835 reported that bees 'brought from London in a wire case' arrived safely in Van Diemen's Land (Tasmania) in 1830; they swarmed several times in the first year. Barrett (1995) discussed whether bees were allowed to fly during such voyages.

In 1857 J.S. Harbison used small boxes (30 x 30 x 15 cm) when transporting bees by sea from Pennsylvania to California, in order to reduce freight charges (Watkins, 1966). Combs were fixed in place with strips of wood, and each little colony received at least one comb containing eggs. Shortly before the start of the journey, a large opening was cut in the box and another (ventilated) box placed over the first, for the bees to cluster in during hot weather. In the ship, hives were placed under an awning on the hurricane deck where they would get most air. On arrival at Colon in Panama the bees were allowed to fly before

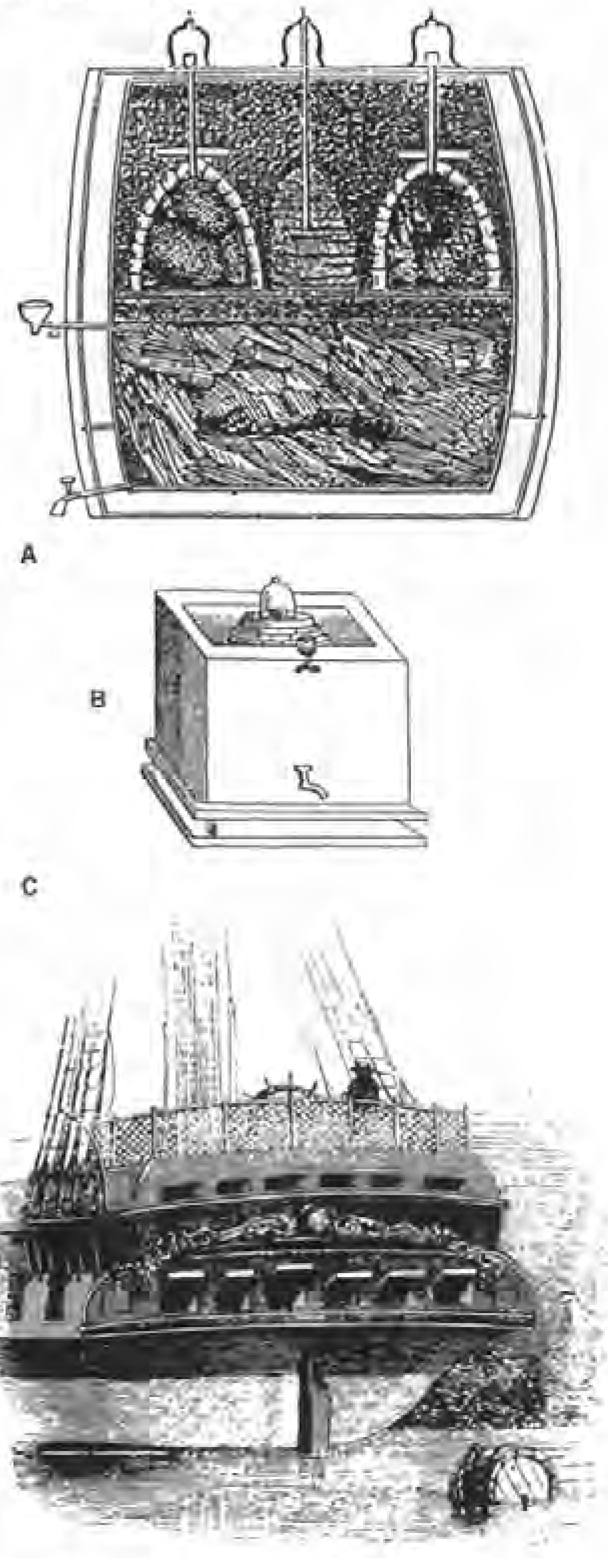


Figure 36.1a Cotton's 1842 method for transporting hives of bees from England to New Zealand. **A** Hogshead containing 4 skeps packed above ice. **B** Single skep cooled by running water, 'placed in the bathroom at the stern of the ship'; the stern is shown in **C**.

*From 1786, ice had been collected from Scottish lochs in winter and stored in local earth houses, for packing round salmon sent to London; it was not manufactured by refrigeration until about 1900.

being carried across the isthmus to the Pacific; see Section 36.22(e).

The hive shown in Figure 36.1b was described by someone who saw a number in transit to California in 1860. 'When carried on land, the hives were turned bottom upward, but when taken on shipboard, they were set in their natural position. We learn that by this arrangement there has been little loss among the hundreds of swarms that have gone to California during the past four months.'

After about 1900 most colonies were transported in movable-frame hives (Chapter 41). By 1903 two small colonies had travelled successfully from England to Bombay, the voyage taking only 18 days. Each consisted of 'three frames of brood and one frame of heather honey, with about a quart of bees and a queen, and ventilation was given by an opening covered with wire gauze'. The bees were allowed to fly at Port Said and Aden, and again in Bombay before travelling on by mail train to the Nilgiri Hills west of Madras. They were put into full-size modern hives, and the queens began laying as soon as the bees were fed (Francis, 1903).

In 1983 in Mauritius (20°S), Claude Rouillard told me how he had transported Italian bees from Marseilles in France (45°N) in spring 1934. A colony on 3 or 4 frames was sealed in a hive for the voyage, which took only 15 days through the Suez Canal. On the advice of the freight manager of the shipping line (Les Messageries Maritimes), Rouillard booked a *de luxe* cabin, with enough space for the hive and the large box in which it was packed. While the ship was in hot latitudes he kept wet towels on the hive, and in port he bought honey in the market and fed it to the bees. When he reached Mauritius many bees were dead, but the queen had survived and also enough bees to build up the colony. This colony was used to rear many queens; they mated with local drones, and their colonies were more resistant to wax moth infestation than local bees (*A. mellifera unicolor* from Madagascar); they also gave twice as much honey per colony.

36.14 Transport of honey bees by air

The first witnessed flight in a powered aeroplane, by Orville and Wilbur Wright of Dayton in Ohio on 20 September 1904, had an incidental connection with bees. A.I. Root of Medina, Ohio, Editor of *Gleanings in Bee Culture*, was the sole eye-witness of the flight, and the only first-hand description of it was published in his journal on 1 January 1905 (Bee World, 1968).

Bees were first transported by air on an internal

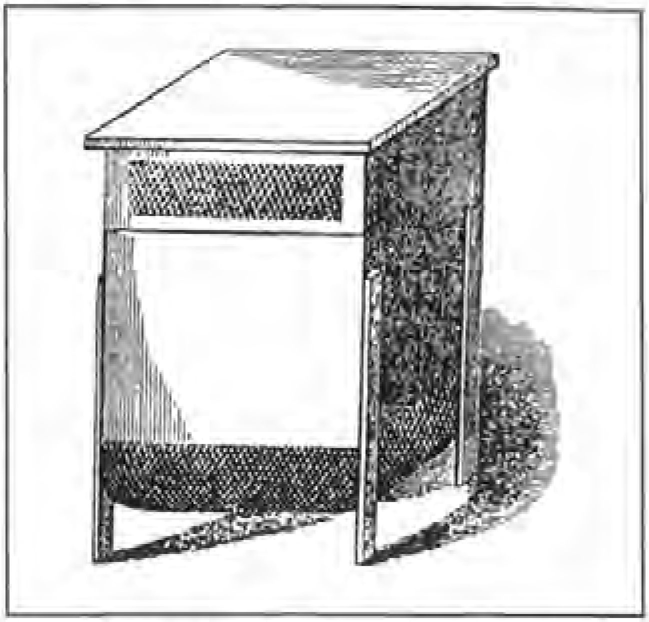


Figure 36.1b Sketch of a 'large chamber hive' in which bees were transported to California (American Agriculturist, March 1860).

flight in the USA (American Bee Journal, 1928): 'Bee royalty has taken to riding the air mail. Twenty-five queens were passengers on the Boeing air mail plane from Medina, Ohio, to Bakersfield, Calif. They left at 5.10 pm July 11th, arrived in Salt Lake [Utah] at 9.00 am on July 12th, and expected to be at their destination before dark. Their passage cost $10.40.'

In 1932 packages of bees (Section 44.3) were sent by air from the Caucasus to various destinations in the USSR (Komarov, 1933). Transit times were up to 3 days, and often more hours were spent on the ground than in the air. Four packages, each with 1.2-1.7 kg bees, were taken on the longest trip. Their food consumption was between 0.3 and 0.65 kg, and only a small percentage of the bees died. Comparing bee losses and food used when packages were sent by air and by rail, Komarov concluded that 'the high cost of aeroplane transportation is fully compensated by the reduction of expenses ...'.

The first successful international flight may have been that of 24 separately caged queens in a nucleus hive, sent from the USA to South Africa in 1944; the journey took 6 days. Workers had access to candy and wet cotton wool 'that could be moistened during the journey', and only one queen died; Lundie (1944) gave details.

After the end of the Second World War in 1946, the development of postal and passenger air services gave a considerable impetus to the air transport of bees. Some of the early difficulties were discussed in

1948 issues of *Bee World*. In that year there were unsuccessful attempts to send queens by air to Australia from both the USSR and Italy (Bee World, 1949a). The first large cargo of package bees was sent from California to Montana with syrup as food, and when the air pressure dropped this escaped from the feeders and formed a sticky pool on the floor, but the bees in the packages were unharmed (1948, p. 19). However, packages travelled satisfactorily without food from Mississippi to Ottawa in Canada; this avoided such accidents and also reduced the weight of the package and hence the freight cost (p. 75). The effect of reduced air pressure on a queen's future laying ability was discussed on p. 43.

In 1950, packages were sent from Denmark to Greenland by seaplane Section 36.22(d), and during the 1950s *New Zealand Beekeeper* recorded several advances in air transport of bees. In 1954 three colonies were successfully introduced in the Chatham Islands, after failures with sea transport since the 1890s. Roberts (1957) designed a special container for sending bees by air.

Air transport of bees had greatly increased by the 1980s. For instance in 1986 New Zealand exported 16.5 tonnes of bees in packages, some to Pacific islands, and many more to Canada (10,000 km away); the latter were sent in April which was autumn in New Zealand but spring in Canada.

36.15 Transport of immature stages and semen

A.I. Root (1873) in the USA first suggested transporting eggs of honey bees, as cheaper than transporting queens. He offered to 'mail to any address a piece of comb containing freshly laid eggs from an imported Italian queen' on receipt of 25 US cents. Later experience showed that the transit time must not exceed 4 days, and that success was more likely with newly hatched larvae than with eggs. Johansson (1964) referred to other shipments within the USA, and to C.C. Miller's claim in 1909 that eggs were sent in Europe by surface mail.

In 1922 the USA passed legislation to prevent introduction of the tracheal mite of honey bees (*Acarapis woodi*); it prohibited the import of live adult honey bees from Europe. In 1923 Canada passed similar legislation which was, however, interpreted as including all stages of development. For nearly forty years afterwards, there was virtually no introduction of honey bees from Europe into the USA or Canada. Then, in order to obtain fresh breeding stock, M.V. Smith in Canada developed a method for transporting non-adult bees (eggs, larvae and pupae) in a portable incubator. This enabled him to import some hundreds of larvae of different races from Europe into the USA in 1961 (Smith, 1962), and their progeny was allowed to enter Canada.

Temperatures are less critical for transporting drone semen than adult or immature drones, and queens were successfully inseminated with transported semen that had been stored for 68 days. In 1959 Mackensen inseminated 10 queens with semen sent by ordinary mail within the USA, and 8 produced worker progeny. Taber (1961) described a method for sealing semen to be transported in a tiny glass tube, with as little air as possible. He encountered various difficulties, but 6 mailings within the USA gave 3 successes, and of 39 queens inseminated with semen mailed between North America and another continent, 8 laid fertile eggs.

36.2 European honey bees to the Americas

In 1617 William Vaughan had sent settlers from Wales to establish Cambriol, a colony near Ferryland in the south of Newfoundland, Britain's earliest colony. In *The golden fleece* (1626), Vaughan referred to forests there: 'Out of these woods we may have pitch, tarre, rosen, turpentine, frankincense, and honey out of the hollow trees, as in Muscovy, and heretofore in our owne woods before they were converted to the iron mills'. It is not clear whether he knew that honey bees were not native to North America.

Figure 36.2a Type of ship that may have landed the first honey bees in the New World by 1617, and the first honey bees in the North American mainland in 1622. The vignette, from Robert Rich's *Newes from Virginia* (1610), probably represents the *Sea Venture*, wrecked off Bermuda in 1609.

36.21 The first known transport of honey bees to the New World

There is an unequivocal record from 1617 of honey bees in the Bermudas. In 1609 the *Sea Venture* (see Figure 36.2a), flagship of the second expedition to America by the Virginia Company of London, had been wrecked off St George's, the most northerly island in the Bermudas which are nearly 1000 km ESE of North Carolina.[*] The Virginia Company took possession of the Bermudas, and in 1612/13 other settlers were sent from England, including Robert Rich who reported frequently to his brother Sir Nathaniel Rich in England. Robert was active in propagating crop plants, and he also imported goats and cattle and honey bees. On 25 May 1617 he wrote a letter to his brother: 'The bees that you sent doe prosper very well ...' (Section 31.1). At the time the bees arrived, Government House was on St George's Island, and the garden was probably on the site where the building known as the Globe Hotel/Confederate Museum was built. In 1618 another correspondent in Bermuda wrote to say that 'the heifers do prosper and the bees, but not so well'. However, in 1662 honey and beeswax were among commodities exported to the West Indies and sometimes to the American colonies, and such exports were referred to again in 1679. Kevan (1981) and Hilburn (1989) gave no further information about the bees in the 1600s, but provided background information. In 1991 Charlotte Langley established that no more was to be found in the Bermuda Archives. In the late 1980s Bermuda produced honey valued at US$150,000 annually.

Table 36.2A

Mainland North and Central America: dates of first records found for exotic hive bees (*Apis*) and for *Varroa jacobsoni*

Entries are made only for countries where a date was found; ( ) indicates an unsuccessful introduction.

Aml = *A. m. ligustica*; other races are not specified here.

tAm = tropical African or Africanized *A. mellifera*.

mf = movable-frame hive.

Varroa = first documented finding of *Varroa jacobsoni* (Matheson, 1995, 1996); see end of Section 36.9.

yes = probably present, from other records.

Country	*European A. mellifera and where from*	*tAm*	*Varroa*
North America			
USA, east	1622, England	1960*	1987
	1859, *Aml* Germany	(1980s)	
		1990†	
USA, west coast	1853, E USA	(1985)	
	1859, *Aml* E USA	1994	
Canada, east	1776, Scotland	no	1989
Canada, west coast	1858, Oregon, USA	no	
Mexico	1500s-1700s	(1956?)	1992
	1911, *Aml* USA	1986†	
Greenland	(1950, Denmark)		
Central America			
Belize	1957, Mexico	1987†	1995
Costa Rica	by 1830	1983†	
El Salvador	by 1855	1985†	
Guatemala	1830, Costa Rica	1985†	
Honduras	1850s or 1860s	1985†	
Nicaragua	1850-1900?	1984†	
Panama	by 1960	1981†	

* Semen received and used for rearing bees.

† Arrived by natural swarming.

36.22 North America

Table 36.2A lists the date of the first known entry of European honey bees into the USA, Canada and Mexico. Honey bees were taken to Bermuda, Virgina and what is now Massachusetts within twenty years of the establishment of the first settlements there, in 1609, 1607 and 1620, respectively. In mainland North America honey bees populated individual regions by swarming, or in hives taken by settlers when they moved overland, usually westward.

(a) Direct transport from Europe to what is now the USA

One of the Virginia Company's expeditions had led indirectly to the introduction of honey bees to Bermuda by 1617, and a later expedition was almost certainly the first on record that took honey bees to the American mainland. At a Quarter Court held in Virginia on 21 November 1621, a Commission was granted to Masters of four ships (of 40 to 200 tons): John Huddleston of the *Bona Nova*, Thomas Smith of the *Hopewell*, Daniell Gale (or Gate) of the *Darling*, and Captain Thomas Jones of the *Discovery*. On 5 December 1621, the Council of the Virginia Company in London wrote to the Governor and Council in Virginia:

> We have by this Ship [from the context, either the *Bona Nova* or the *Hopewell*] and the *Discovery* sent you divers sorte of seed, and fruit trees, as also Pidgeons, connies [rabbits], Peacock maistives [mastiffs], and Beehives, as you shall

[*] This event provided the theme for Shakespeare's *The tempest*, which was probably written in 1611.

by the Invoice perceive; the preservation and encrease whereof we recommend unto you.

At this period the voyage could take 6-8 weeks. The arrival of the hives, presumably early in 1622, is not recorded, but we have no reason to believe that they did not reach Virginia safely, because by May 1622 the *Discovery*, the *Bona Nova* and the *Hopewell* had delivered 20, 50 and 20 settlers. D.A. Smith (1977) gave further details from *The records of the Virginia Company of London*.

Early settlements were near the James River, and in 1985 John Adams and I visited the place where the ships unloaded their cargoes: a wharf (no longer existing) under a bluff where the Appomattox River flows into the James. The town is now called Hopewell, and a nearby farm had previously been named Hopewell after the ship.

Some 700 km farther north in Massachusetts, honey bees were said to have 'spread through the woods' in 1639, so there was probably a direct introduction there; the *Mayflower* had landed at Plymouth in 1620. In 1654/55, Swedish settlers in Delaware were to import honey bees, but probably did not – or the bees died – since tallow candles were in use later (Oertel, 1976b). Oertel also referred to a statement by Haydn in 1904, that bees were introduced into Boston, Massachusetts, in 1670, and 'have since spread over the continent'.

Barton (1793) quoted W. Bartram* as saying that in 1763 honey bees were imported into Pensacola in Florida by the English 'who took possession of Florida [from the Spanish] this year'. Pensacola is only 25 km from Alabama, and in 1773 Bartram had a hive in Mobile, Alabama, 'lately brought from England' (Oertel, 1976c).

(b) Spread within the USA and Canada

Table 36.2B gives the first dates found for the presence of honey bees in different Eastern, Central and Western states of USA and provinces of Canada; it indicates the rate of spread of the bees, by swarming and by human agency. Oertel (1976a) described and mapped routes in eastern USA likely to be followed by settlers transporting bees, and by swarms.

(c) Introductions to what is now eastern Canada

In 1741 Saint-Ours Deschaillons found a swarm of bees in the neighbourhood of Fort Saint-Fréderic (NY) near the south end of Lake Champlain (*Bulletin*

*William Bartram (1739-1823), an American who was Botanist to King George III of Great Britain.

Table 36.2B

States of the USA and provinces of Canada: dates of first records found for honey bees

I = imported (from Europe); T = transported within the Americas. S = probably spread by swarming; X = not known whether S or T. Unsuccessful introductions are not included.

	Eastern	Central	Western
When only fixed-comb hives were used			
Virginia	I 1622		
Massachusetts	I? by 1639		
Connecticut	S 1644/48		
Pennsylvania	S 1630/1707		
New York	X 1670		
North Carolina	X 1697		
South Carolina	S 1705/12		
Georgia	X 1737		
Tennessee	S 1748/50		
Ohio		S 1754	
Louisiana		X 1758	
Florida	I 1763		
Mississippi	S 1770/75		
Alabama	I 1773		
Michigan		S 1776	
Kentucky	T 1760/70		
Ontario, Canada	I 1776		
Quebec, Canada	T 1790		
Missouri		S 1792	
Indiana		S 1793	
Vermont	S 1794		
Iowa		S 1797	
Illinois		S c.1800	
New Jersey	S c.1802		
Nebraska		S 1810	
Colorado			S 1800/20
New Brunswick, Canada	T after 1812		
Arkansas		S 1818	
Texas		S 1821	
Wisconsin		S 1827	
Oklahoma		S 1832	
Utah			T 1848
Nevada			T by 1852
After the movable-frame hive was developed			
California			T 1853
Oregon			T 1854
Washington			T ?1856
British Columbia, Canada			T 1858
Arizona			T 1872
New Mexico			T after 1872

(cont.)

(cont.)

	Eastern	Central	Western
Canada			
Manitoba			T by 1860s
Alberta			T 1885
Saskatchewan			T by 1900
Prince Edward Island		T 1830	
Newfoundland	T 1927		
Alaska			T 1924
Yukon, Canada			T ?1981

historique des Recherches, 1946, p. 25), and bees from that area might have spread within a few years to the border of what is now Quebec, 80 km north. But the Swedish naturalist Pehr Kalm travelled in the valley of the St Lawrence in 1749, and he stated categorically that it had neither honey bees nor beekeeping; see Oertel (1976b). Records were found of three introductions in the late 1700s (Section 31.23,a,b,c): 1776 in Hastings county and 1793 in Kent county (both now in Ontario), and 1790 in Quebec province.

Labrador, which with Newfoundland now forms Canada's tenth province, was probably without bees until 1927, when Sir Wilfred Grenfell wrote to say that he had 'made an experiment with bees imported from Canada, and felt greatly in need of advice' (Moir, 1928). Bees did not flourish in Newfoundland because of the low temperatures.

(d) Introduction to Greenland

Hertz (1990) collected the following information. Schwarz-Hansen (1950) sent (probably four) packages of bees from Denmark to Narssarsuaq in Greenland by seaplane in May 1950 and established them in two locations; more were sent in August. Later reports (see Bastholm, 1950/56) show that some colonies lived for a few years at various places between 60° and 66°N, and even produced some honey, but only one survived until 1954. Difficulties included the very long winters (during which a warm *föhn* wind could stimulate the bees to fly), and lack of constant expert attention – which depended largely on beekeepers from Denmark.

(e) Introductions to western USA

Mormons arrived in Utah from 1847 onwards, and the first bees were taken there on the back of a covered wagon in 1848. Brigham Young said in 1851 that 'several hives were responding well to conditions in Utah' (Nye, 1971). According to the *Millenial Star* for 8 November 1862: 'The honey bee has also been successfully introduced into the southern counties [of Utah], and a considerable amount of honey is being made there.' By 1852 they had reached Nevada to the west.

Two 1843 migrants had reported that there were no honey bees beyond 'the waters of Kansas'. In fact, great difficulty was experienced in getting bees to the west coast, although this was not always understood in the east. Howison who arrived in Oregon by sea in 1846 wrote: 'the honey bee has not yet been naturalized ... which every one seems to notice with surprise' in view of the many flowering plants (Williams, 1975). Until 1914 when the Panama Canal was opened, the only sea route from the east was round Cape Horn, with two transits across the tropics, and in the 1850s the voyage took nearly 13 weeks. An overland route by wagon or mule train had to cross desert country and then the Rockies.

From 1853 hives of bees were successfully transported by taking them south to Panama by sea, then overland 'on the backs of natives' across the Panama isthmus, and north by sea again (Watkins, 1968a). W.A. Buckley did this in 1852, leaving New York on 24 May with three hives in his baggage. One died on its way to Panama, and one died there from the heat. The third reached San Francisco in California after 5 weeks, on 28 June, but no more seems to have been heard of it, and it is presumed to have died. Then in March 1853 the botanist C.A. Shelton (Figure 36.2b) succeeded, following a similar route; he probably knew more about bees than Buckley. A plaque in what is now San Jose Municipal Airport commemorates the event (Shriver, 1982) and records that, from the initial 12 hives, 'only enough bees survived to fill one hive, but these quickly propagated, laying the foundation for California's modern beekeeping industry'.

In 1856 William Buck took further colonies across Panama (Erickson, 1943; Watkins, 1968c), as Harbison did (Section 36.13).

About 1860, Leonard Kennedy successfully transported 200 colonies from Wisconsin to California via Panama. Gleanings in Bee Culture (1989) printed the account of the journey as he told it to his daughter many years later; this shows the beekeeping skill and expertise involved in such journeys.

The year 1809 has been quoted for the first introduction of honey bees to Alaska from Russia, for instance by Pellett in 1947 (Watkins, 1968e). The Imperial Russian Government had settlements round Sitka from 1732, but no evidence has been found to support the presence of honey bees in Alaska until well after 1867 when this state was transferred

Figure 36.2b The botanist C.A. Shelton 'in travelling costume' (California State Library). In 1853 Shelton brought honey bees to California, and these were the first to survive

to the USA. Russian records of the Russian-American Company from 1800 to 1837, searched by Dorothy Galton, contained detailed lists of goods taken to Alaska, including honey for medical purposes and for officials, and beeswax candles for use by the church and also certain officials. But bees were not mentioned. The earliest record I found (Alberts, 1930) was in 1924, when colonies were brought to the Anchorage area and to Haines 1800 km farther east.

(f) Introductions to what is now western Canada

Bees were established on the west coast of Canada a few years after they first reached California. Turnbull's history of beekeeping in British Columbia (1958) started in May 1858 when the ship *Pacific* reached Fort Victoria on Vancouver Island with a consignment of bees sent to J.B.D. Ogilvie by W.H. Hoy of San Jose, California. The *Victoria Gazette* invited readers to call to see 'the little workers'. No more is known about these bees, but in April 1860 Ogilvie received two hives from Oregon which were also described as 'the first honey bees brought to this colony', and they produced about 10 pounds of honey within two months.

In the Prairie provinces, honey bees reached Manitoba by the 1860s (end of Section 41.2). In 1885 hives of bees were sent to the Henderson family in Alberta from Ontario, by rail to Calgary and thence by wagon (Alberta Beekeepers' Association, 1983). In 1891 Mr Mackenzie brought further hives by barge up the Saskatchewan River, and bees were certainly kept in Saskatchewan by 1900. The Canadian Dominion Government started its first apiary in Manitoba in 1889.

(g) Introduction to southern USA, and Mexico

Statements have been made implying that early Franciscan or Jesuit missionaries kept bees in the Sonoran desert spanning the Arizona-Mexican border, possibly as early as the 1500s, but I have been unable to identify or locate any original report. The earliest confirmed date for Arizona is much later; Waller (1992) found an entry in *Arizona Citizen* for 27 July 1872: 'The bees brought here from California [San Diego] by Gen. J.B. Allen are doing very well. They swarmed last week and were hived.'

We do not know when honey bees first reached New Spain (Mexico). As early as 1513, Herrera's *Obra de agricultura* mentioned the difficulty of transporting bees to the newly discovered Indies. Brand (1970, published 1988) concluded from various sources that the Spanish probably introduced honey bees in the 1520s or 1530s. Hernández was in New Spain from 1570 to 1577, and he described different kinds of honey there, including one 'entirely similar to Spanish honey, identical and produced spontaneously by bees like those of Spain in hollows of trees which the Indians cut down and collect, in their apiaries'. Perkins (1926) quoted verbatim from a report written in the 1600s: a swarm must have settled on a ship about to sail from Spain to the New World, and on reaching what is now Vera Cruz the bees flew ashore and settled in a cask which a priest provided as a hive. Cobo's 1653 book mentioned Spanish bees as well as four types of stingless bees in the Indies. However, according to Stoll (1887), introduction of honey bees into Spain's New World had been prohibited; this might have been done to protect either Cuba's wax production and exports or

the interests of beekeepers in Spain. Calkins (1975) thought it most probable that the first honey bees were introduced from Cuba in 1764, and Clavigero's *Historia de Mexico* (1780/81) included the passage:

> There are at least six different kinds of bees. The first is the same as the common bee of Europe, with which it agrees not only in size, shape and colour, but also in its disposition and manners, and in the qualities of its honey and wax.

Mexico became independent in 1821, and before 1830 there were general introductions from Europe and the USA. Honey bees also entered Mexico from Texas and California after these states were settled (Brand, 1988). In 1855 Squier remarked that European bees had 'long' existed in Mexico.

The Yucatan peninsula in Mexico must be considered separately. Clavigero (1780/81) mentioned the bees in Yucatan and neighbouring Chiapas as being without a sting. Calkins (1975) examined the evidence and concluded that European (probably dark northern) bees were first introduced about 1900.

36.23 Central America

The few historical records of European honey bees in mainland areas south of Mexico are relatively late (Table 36.2A). Although Guatemala adjoins Mexico, the earliest record found for Central America was of bees taken to Guatemala from Costa Rica in 1830 (Stoll, 1887); bees must therefore have reached Costa Rica before 1830. In Belize, which also adjoins Mexico, a Veterinary Officer John Robbins is said to have brought the first hives of European bees to the north in 1957, via Quintana Roo in Mexico (Mulzac, 1979).

Kent (1979) suggested that in the 1850s beekeeping in Central America was concentrated in highland districts of Costa Rica, Guatemala and Honduras, where settlements and populations were situated. In 1855 Squier reported the presence of European bees in El Salvador, and they could have come from Guatemala. Kent mentioned an unconfirmed belief in Nicaragua that the Spanish kept bees round Old León, and that modern beekeeping with them was thought to have been started between 1850 and 1900 by Germans, to pollinate their coffee crops. Beekeeping with honey bees came very late to Panama, but the bees were present by 1960. Hives had been taken across the isthmus *en route* to California in 1852, 1853 and 1860, but I found no mention of bees escaping there.

36.24 Caribbean and neighbouring islands

There are more, and earlier, records of introductions to some of the islands (Table 36.2C), starting with Bermuda by 1617 (Section 36.21). The bees may have been taken to Barbados next, since Purchas said in 1657 that they were not successful there because they were all eaten by certain birds – probably a species of kingbird, *Tyrannus*.

Table 36.2C

Caribbean and neighbouring islands: dates of first records found for exotic hive bees (*Apis*)

For explanatory notes, see Table 36.2A. *Varroa* is so far recorded only in Grenada and Puerto Rico (both 1994).

Country	*European A. mellifera (or other hive bees) and where from*
Aruba	by 1928, Netherlands
	1939, *Am* Trinidad
Bahamas	by 1944
Bequia	?late 1800s, Europe
Barbados	(by 1657, England?)
Bermuda	by 1617, England
Cayman	by *c.*1885, England?
Cuba	1764, Florida, USA
	1904, *Aml*
Curaçao	(1915)
	1920
Dominica	by 1978
Grenada	1988
Guadeloupe	?1689, France
Hispaniola	1781, Martinique
Jamaica	(*Aml* 1859, USA)
Martinique	(by 1689, France)
Montserrat	by 1718/20
Puerto Rico	by 1864, Switzerland
St Kitts-Nevis	by 1720
St Lucia	by 1960s
St Vincent	by 1988
Trinidad/Tobago	by 1901/02, *Aml*
	1979, *tAm* Venezuela (not Tobago)
Virgin Islands:	
UK	by 1989
USA	by 1989, St Maarten?

The British, who captured Jamaica from the Spanish in 1655, are thought to have introduced 'dark English bees' (Chapman *et al.*, 1970; Beetsma, 1989). Italian bees were brought from the USA after 1859, and further bees from Costa Rica in the 1890s.

Correspondence in the Archives Nationales de Paris gives some details of introductions into Guadeloupe and Martinique in the late 1680s. In 1689

Comte de Blaynac wrote a letter to Louis XIV, King of France (Document $C^{8A}5$, folios 27-28) telling him that Sieur Duclerc, Major of Guadeloupe, wanted to bring honey bees to the island from the Landes of Bordeaux, but success was considered unlikely: M. de Blaynac had already brought some from his home, and those that did not die on the journey perished in Fort Royal (Fort-de-France in Martinique, from which Guadeloupe was administered). Further, it was almost impossible to protect hives from ants and the many other insects. Folio 304 shows that Duclerc had previously been charged with bringing hives of honey bees to Guadeloupe, but had not done so. A letter from Duclerc on folio 328 states: 'honey bees have been obtained since I returned to Guadeloupe'; there were two swarms from these bees, which made black wax, and this was sent to France to find out if its colour could be changed. (In both letters, Duclerc's term is *mouches à miel*, used for honey bees, but it seems possible that in the second he was referring to stingless bees, whose wax is often very dark.) Duclerc had also written to ask a merchant in Nantes in France to send him honey bees, and said that he would use every resource to ensure their success.

Pinchon (1964) referred to Document $C^{8A}5$ in the Archives as reporting also the importation of honey bees to St Christopher in 1688, but although the island is mentioned, the passage is not in the folios cited or in any other. The first record for St Christopher (St Kitts) is a letter from the Rev. William Smith written from between 1716 and 1720: 'We have no bees that are hived, and still we meet with excellent Honey, made by the wild Bees in the Woods, about the Salt-Ponds in St. Christopher's, etc.' The passage is unlikely to refer to stingless bees, since (Schwarz, 1948) St Kitts is on the edge of their distribution. Crane (1989b) gave some further details.

The year 1764 is usually quoted for the first introduction of honey bees to Cuba (e.g. Oertel, 1981). By the Treaty of Paris in 1763, the English got Florida from the Spanish in exchange for Havana (Cuba) which they had taken in 1762. Gerstäcker (1862) quoted a statement made by Don Ullos, that the bees 'multiplied exceedingly in the vicinity of Havana during the brief interval since 1764. Before that date there were no bees on the island except such as belonged to wild and other species.'

Section 31.32 records the 1781 transport of bees from Martinique to Santo Domingo in Hispaniola, now divided into Haiti and the Dominican Republic. Records of introductions of European bees after 1800 – which may or may not be the first ones – have been found for a few other islands. Beekeeping is supposed to have started in the Cayman islands about 1885, when wild colonies were collected from hollow trees for the purpose (Chalmers, 1984). The first European bees imported to Curaçao, in 1915, failed 'because the bees flew away due to strong trade winds', but 1920 imports did better.

36.25 South America

Table 36.2D shows that European honey bees were introduced to countries of South America comparatively late, starting in 1839. A belief that the bees were present earlier in South America was based on a passage in a letter written in Italy by Father Cardiael some time after 1768: 'On various occasions I explained the method used in Spain by those who keep hives ....' However, Nogueira-Neto (1964, 1967) interpreted this to mean that the natives should use the better Spanish method with their stingless bees, not that European bees were already kept in settlements established by the Spanish. Extensive studies of the records convinced him that at this period there were no populations of *Apis mellifera* in that part of America (Brazil).

On 12 June 1839 Emperor Dom Pedro II in Portugal issued a decree giving the exclusive privilege of introducing bees from Europe and Africa to Father Antonio Pinto Carneiro, and he was instrumental in transporting 100 colonies from Porto in Portugal to Rio de Janeiro in Brazil in that year. Marques (1845) referred to this as the first introduction of the bees to Brazil; see also Priore (1992). Of the 100 colonies 7 arrived alive and survived, and in 1859 Branco stated that 'all the honey bees in Brazil, now 30,000 colonies, are descended from those introduced by Father Antonio Carneiro, who was the first to introduce the bees to Brazil'. Later writers reiterated that no more had come from Europe by 1859 (Nogueira-Neto, 1990b). However, a letter from Isaac Pask in *The Adelaide Observer* for 15 November 1845 recorded that two hives of bees sent from England to Brazil arrived there safely on 27 December 1844. They were taken to the Machai Mountains '250 English miles from Rio'.

Some bees had been taken to Minas Gerais north of Rio de Janeiro in 1845, and they 'multiplied exceedingly' there. German settlers introduced 'black' bees in southern Brazil (Noguiera-Neto, 1962), and probably also in Rio Grande do Sul, Santa Catarina and Paraná.

There are reports of introductions of honey bees or hives to a few other countries (Table 36.2D) around 1839. In Uruguay, about 1500 km south of Rio, Toscano (1979) said: 'The first hives of which record has been made were brought to the Colonia region by the

Table 36.2D

South America: dates of first records found for exotic hive bees (*Apis*) and for *Varroa jacobsoni*

For explanatory notes, see Table 36.2A.

Country	*European A. mellifera (or other hive bees) and where from*	*tAm*	*Varroa*
Argentina	by 1839	1965* or 1969*	1976
	1850, *Aml*		
Bolivia	by 1914/15, *Aml*	1967*	1980
Brazil	1839, Portugal	1956, S Africa and Tanzania	1978
	1845, *Aml* (late 1950s, *A. cerana*, Hong Kong)	1956 *A.m. capensis*	
Chile	1840, Germany		1992
	1844, *Aml* Italy		
Colombia	by *c.*1855	1978* or 1979*	1994
Ecuador	date unknown	1981*	yes
French Guiana	by 1902	1974*	
	1969, *Aml* Italy		
Guyana	1920, *Aml* USA	1975* or 1976*	
Paraguay	*c.*1900, Chile	1965*	1975
Peru	date unknown	1977*	yes
Surinam	late 1800s	1975*	
Uruguay	1839, Argentina	1971*	1976
Venezuela	after 1866	1977*	1991
Falkland Islands	1950?	no	
	*c.*1980 NZ		

* Arrived by natural swarming

Argentine national hero Bernardino Rivadavia in 1839.'

According to Apicoltor Chillán (1989): 'The first honey bees in Chile [on the west coast] were brought to the Valdivia region by Germans in 1840.' Around 1855 a great flood of German agricultural and artisan immigrants established themselves in southern Chile, and they brought many colonies of bees from eastern Europe (Nogueira-Neto, 1967). According to Buttel-Reepen (1906), honey bees were in Colombia about 1855. In Paraguay, German bees were introduced from Chile about 1900 (Peppino, 1981), and by 1911 those in Asunción had 'become wild' and invaded all the woods and had reached as far as Puerto Bertoni on the Argentina border, having traversed 60 leagues (about 300 km) of woodland. There were still no European bees in Venezuela in 1866 (Nogueira-Neto, 1967), and probably not in other countries (Bolivia, Ecuador, French Guiana, Guyana, Peru and Surinam) until the late 1800s.

36.3 European honey bees to Oceania

Table 36.3A gives dates of first known introductions to Australia, New Zealand and New Guinea, and some smaller islands of the Pacific. Barrett (1995) provided many details about early introductions into Australia and New Zealand.

36.31 Australia

The first known plan to take European bees to Australia was by G. Blaxland in 1805 (Section 36.13), but Barrett (1995) found no evidence that Blaxland took any bees on board. The bees Samuel Marsden brought from Rio de Janeiro in 1810 are likely to have been stingless bees (Section 36.81).

In 1821 W. Kermode was the first to succeed in bringing honey bees to Hobart in Tasmania, in the *Mary* from Liverpool in England; they were presented to the Governor (Cunningham, 1971) but died. Others arrived in Hobart from London in 1831 (with 200 convicts) and survived (Barrett, 1995). Captain Wallace transported a number of hives of bees from England in the *Isabella* which sailed from Cork in Ireland and arrived in Sydney, NSW, in March 1822, and the bees became 'completely established'. Mr Parr in Sydney had four hives, and one was advertised for sale on 2 June (Mocatta, 1962/63).

European honey bees do not seem to have become established in other states of Australia for another twenty years. Swan River Colony in Western Australia was founded in 1829, and bees arrived there from England in 1830 and 1834, on the *Warrior* and the

Table 36.3A

Countries and islands of Oceania: dates of first records found for exotic hive bees (*Apis*)

For explanatory notes, see Table 36.2A.
No known successful introduction of tropical *A. mellifera*.
See footnote for *Varroa*.

Country	*European A. mellifera (or other hive bees) and where from*
Large islands	
Australia:	
Tasmania	(1821, England)
	1831, England
NSW	1822, England
	1877, *Aml* USA
S Australia	by 1846
	1883, *Aml* Queensland
W Australia	(1830, England)
	1846, S Australia
Queensland	by 1851
	(1872, *Aml* USA)
	by 1880, *Aml* Italy
Victoria	1862, *Aml* England
New Zealand:	
N Island	1839, England
	c.1883, *Aml* Italy
S Island	1842, Australia; also England
	1879, *Aml* USA
New Guinea:	
Irian Jaya	by 1983
	1985/86, *A. cerana* Indonesia
PNG	1948, *Aml* Australia
	1987*, *A. cerana* Irian Jaya
Small islands and groups (no *Varroa* recorded)	
American Samoa (USA)	by 1976
Chatham (NZ)	c.1954, NZ by air
Cook	Rarotonga by 1890
Easter (Chile)	1930, Chile
Fiji	by 1924
	1924, *Aml*
French Polynesia	by 1902, *Aml*
Guam (USA)	1907, *Aml*? Hawaii
Hawaii (USA)	1857, USA
	1880, *Aml* USA
Kermadec (NZ)	Raoul 1961
Line (Kiribati)	by 1973
Marshall	1979, Hawaii
Micronesia Federation	by 1976
New Caledonia (France)	by 1902, *Aml*
Niue	1952, 1963, NZ
Norfolk	1840s
Northern Mariana (USA)	by 1951
Palau (USA)	1950s, USA
Pitcairn (UK)	(1963), NZ
Solomon	c.1960, Australia
Tonga	by 1968
Tuvalu	1983, NZ
Vanuatu	1910s or 1930s, Aust./NZ
Wake (USA)	1971 or earlier
Western Samoa	by 1960

* Arrived by natural swarming. In 1985/86 *A. cerana* was taken to Irian Jaya and spread to PNG, where *Varroa* was reported in 1986.

James Pattins, respectively, but they died (Coleman, 1956). In March 1846 Lt. Helpman, RN, took bees to the Colony by sea from Adelaide or Launceston, so they must have been in South Australia before then. In 1851 W.T. Lyon saw hives of bees when he arrived in Moreton Bay, Queensland, on the second immigrant ship (Weatherhead, 1986). Italian bees, which had been introduced to England in 1859, were imported into Victoria in 1862 (Section 36.51).

36.32 New Zealand

In North Island, the first known successful introduction was by Miss Bumby in 1839. She brought two skeps of black bees in the *James* from England to Manunga Hokianga, the voyage having lasted 173 days (Winter, 1954; Dawson, 1980b). About 1840, W. Calypso sent his bees by special messengers into the 'Big Bush', where they were liberated and did well: 'and from them I believe all the bees of this provincial district, and further, are descended' (Colenso, 1895). Stevenson (1996) related how French Roman Catholic priests introduced honey bees to the Bay of Islands in 1842.

In December 1841 the *Tomatin* sailed from Plymouth to Wellington 'with a goodly fellowship of emigrants, schoolmasters, deacons, and priests, *with a Bishop at their head*'. The passengers included W.C. Cotton who took hives of bees on board; his proposed method for transporting them was described in 1842 (Section 36.13). According to Woodbury (1858) the voyage was very 'stormy and protracted', which the sailors ascribed to the presence of the bees, and 'the hives were taken forcible possession of, and all thrown overboard, to the indescribable grief and disappointment of their amiable and enthusiastic owner'. Barrett (1996) found evidence which contradicts this, and also shows that James Busby brought three colonies from Sydney in 1843; he kept one and Cotton had two.

In South Island, on 23 April 1842 Dr Imlay brought a hive of bees in the *Brilliant* from NSW in Australia to Nelson, and it survived the next winter (Matheson, 1982). On 11 May in the same year Mrs Allom in England sent a hive made by Neighbour and Sons in the *Clifford*, which arrived safely in Nelson (Allom, 1842; Showler, 1978). She was rewarded by a medal from the Royal Society of Arts and Commerce 'for the introduction of bees to New Zealand', presented to her by the Prince Consort, husband of Queen Victoria (New Zealand Beekeeper, 1996).

36.33 Pacific islands

A. mellifera was not taken to Pacific islands before 1840. The first was apparently Norfolk Island, Australia's penal colony, probably when Captain Maconochie arrived on 6 March 1840 'with his family and 300 convicts'; at any rate the island had 50 bee colonies by 1844 (Barrett, 1996).

In 1852, the Honolulu Agricultural Society in Hawaii offered a premium to the first person to import honey bees into the islands (Watkins, 1968d). Colonies were sent from New England round Cape Horn in 1854, but this and 'several other attempts' failed because the colonies died in the tropics (Ambrose, 1934). The first successful colony (of 'black German bees') was taken from California in the *Fanny Major* in 1857, and arrived 'alive and still well stocked with honey' (Watkins, 1968d). Italians were imported from 1880 onwards (Ambrose, 1934).

Honey bees did not reach other Pacific islands for several decades (Table 36.3A). They were taken from Hawaii to Guam in 1907 (Cockerell, 1937) and from Australia and/or New Zealand to Vanuatu in the 1910s or 1930s (Matheson, 1982). The bees were introduced to Papua New Guinea from Queensland in 1948, and their subsequent spread is described at the end of Section 41.51. Table 36.3A includes dates found of other introductions, and Walton (1976) gave details for some individual islands.

36.4 European honey bees to regions in the Old World

36.41 Asia

From 1581 onwards, the Russians established settlements in Siberia which stretches across northern Asia from the Ural Mountains to the Pacific Ocean, and areas farther and farther east were settled during subsequent centuries. From the late 1700s European *A. mellifera* was transported to different parts of Siberia, but in the records it is not always possible to distinguish between transports of bees and the use of bees already present in hives, or in natural nests (Section 14.7). The following account is based on publications by Shavrov (1889), Popov (1913), Vorozhbitov (1980) and Pankrat'eva and Chernytch (1986), and also much help from Professor Bilash (1993) and Elizabeth Buxton.

The Altai form an extensive mountain system of which the northern Altai are in Siberia, the southern Altai in Mongolia, and part of the western Altai in Kazakhstan. The first written record of honey bees in the region is accredited to S. Pallas, who noted their presence in 1770 when travelling near Ust-Kamenogorsk, Kazakhstan.* The Altai mountains had many forests and much good bee country, where honey hunting and ownership of nests had become established. But there were no honey bees in the southern Altai (Mongolia) which was semi-desert, and even in the northern Altai populations could be wiped out in bad years. *A. cerana* was not present in any of the region.

There seems to have been no hive beekeeping before the 1770s. In 1776 descendants of 'Old Believers' of the Russian Orthodox Church, who had been transported from Poland to Ust-Kamenogorsk earlier in the century, asked P. Berens to help them to take up beekeeping; he was the chief doctor with the Siberian border forces. In 1777, on the order of Major-General A. Skalon, Commander of these forces, 30 log hives containing bees were transported there in winter from Bashkiria in the Urals. They were placed among people in the settlements of Sekosovskoe and Bobrovskoe, but were not well managed and none of the colonies survived long.

In March 1784, 24 log hives with bees reached Ust-Kamenogorsk from Kiev in Ukraine, sent by the sister of Colonel N.N. Arshenevskii, Commander of the Irkutsk Regiment of Dragoons. For the four months' sledge journey they were wrapped in straw and felt, and packed two to a sledge. This introduction was also unsuccessful; the bees died as a result of poor care. Then Arshenevskii brought several log hives of bees to Bobrovskoe from Orenburg province (probably from Bashkiria which is in this province), and this introduction was successful. The resulting beekeeping grew into a flourishing industry. Many new colonies were produced, and distributed to Tomsk (1803), Kuznetsk (1806/07), Biysk, Omsk, Semiplatinsk and many settlements and villages. In 1801 one man successfully petitioned the Tsar (Alexander I) for a piece of land for beekeeping near

*This is about 800 km south of Tomsk, and became the principal centre of the Russian nuclear industry.

Tomsk, and in 1803 the government offered parcels of land there to people who would undertake to keep bees for at least five years or, in default, pay a fine. A special ukase during Alexander's reign (1801-1825) gave practical support to the dissemination of beekeeping through Siberia.

From Tomsk province the bees were taken east to Krasnoyarsk on the Yenisei River (1823), to Zabaikal east of Lake Baikal (1851) and to Buryatia which borders on Lake Baikal and Mongolia (1859). From Zabaikal they reached the Amur basin in 1865. They were taken to Khabarovsk in 1887. In Primor'ye on the Pacific coast *A. cerana* was indigenous, but after the introduction of *A. mellifera* their numbers gradually declined, some moving further north into the taiga. Other *A. mellifera* were taken to Primor'ye from Ukraine in 1904.

The first record found of *A. mellifera* in Mongolia is in 1959, when Ryauzov (1980) said 'the first apiary' was established with 20 hives of bees transported from European Russia. But the bees may have been taken there earlier.

The parts of Asia between the Mediterranean Sea and Persia had native *A. mellifera* races, and Table 36.5B gives some details of introductions of European races into this area. In the whole region east of Persia where *Apis cerana* was the native hive bee, *A. mellifera* was introduced from the 1870s by beekeepers who believed it would be more productive, and Table 36.4A gives first known dates for different countries. Mishra and Kumar (1994) described the bee's spread through India. *A. mellifera* colonies were usually imported in movable-frame hives, and this often initiated movable-frame beekeeping with *A. cerana*, whether or not this species was already kept in traditional hives.

36.42 Africa south of the Sahara

In this region the native tropical races of *A. mellifera* were extensively kept in traditional hives (Chapter 28). In colonial times, especially in the 1900s, a number of Europeans who lived in Africa introduced European bees in movable-frame hives, and dates of some introductions were recorded (Table 36.4B). Attridge (1902) was the first to write about imports of Italian bees into South Africa, and 'Italian' queens were exported from there to six other African countries between 1932 and 1943. Fletcher gave further information (1978) and discussed the pros and cons of these introductions (1973). In 1933 Savory had Italian bees in Zambia, which compared unfavourably with the local bees; Chorley (1936) imported them into Uganda in an attempt to improve 'native

Table 36.4A

Asia except the Middle East: dates of first records found for exotic hive bees (*Apis*) and for movable-frame hives

For explanatory notes, see Table 36.2A.

Varroa jacobsoni probably parasitized *A. cerana* in all countries where it was native, and also *A. mellifera* where it was present.

Country	*European A. mellifera (or other hive bees) and where from*	*mf hive*
Afghanistan	(1955)?	1955
	1961	
	1962, *Aml*	
Bangladesh	no	1936
Bhutan	by 1988, *Aml*	1980
Cambodia	*c.*1983, Vietnam	1950s
China	1896	1896
	1910, *Aml* Japan	
Manchuria	1898	1900/09
India	1880s, England	1880s
	Aml 1880s, England	
Kashmir	1953, *Aml*	1920s
Indonesia, *see under Islands*		
Japan	1875/76, *Aml* USA	1876
Kazakhstan	1770	
Korea (N/S)	1916	1916
Malaysia	1930s	1930s
Mongolia	1959, Eur. Russia	1959
Myanmar	by 1887	1879/82
Nepal	1978, Germany	c.1970
Pakistan	(1927) successful?	1881
	1973, *Aml* Australia	
Russia:		
eastern	(1777, Bashkiria)	1870s
	1784, Ukraine	
Far East	1859, Zaibakal	1904
	1904, Ukraine	
Singapore	by 1930s, *Aml* Australia	1929
Sri Lanka	*c.*1875, Australia	c.1875
	1882, *Aml*	
Tajikistan	1870, Eur. Russia	
Thailand	1953, Australia	1950s
Turkmenistan	1896, Eur. Russia	
Uzbekistan	1876, Eur. Russia	
Vietnam	1908, France	1908
Islands, not off-shore		
Diego Garcia (Chagos)	by 1969	
Indonesia:	(1817)	1880s
Irian Jaya, *see* Table 36.3A		
Java	(1877, *Aml*)	
	1881, *A.m. syriaca* Syria	
	1887, *Aml*	
Maldive	*c.*1960?, *A. cerana* India	

(cont.)

Country	European A. mellifera (or other hive bees) and where from	mf hive
Nicobar/Andaman	early 1970s, *A. cerana* India	by 1980
Philippines	1913	1978
Taiwan	1910s, *Aml* Europe/USA	1910s

beekeeping', but the bees were attacked by a conopid parasite. In general the introductions met with only moderate success.

From the 1960s, importations were probably by air; for instance Italians and Caucasians to Tanzania (Beekeeping Division, 1964); 'acarine-resistant' Banat bees from Yugoslavia to Mauritius in 1964, and Italians to Senegal in about 1965, which did not flourish (Linder, 1967).

There is not much information about European honey bees introduced to North Africa; they were probably of specific races considered desirable, taken after about 1900, as in Egypt (Section 41.71).

Table 36.4B

Africa south of the Sahara, and ocean islands: dates of first records found for exotic hive bees (*Apis*) and for movable-frame hives

For explanatory notes, see Table 36.2A.

Varroa was reported only in Niger (1991) and Senegal (1994), and in the Canary (1993) and Cape Verde (1994) Islands.

Country	European A. mellifera	mf hive
Angola		by 1956
Burundi		by 1967
Ethiopia	*Aml?*	1962
Gambia		by 1970
Ghana		1963
Kenya	1932/43, *Aml**	
Lesotho	1932/43, *Aml**	
Mozambique	1932/43, *Aml**	
Namibia	1932/43, *Aml**	
Rwanda		1952
Senegal	(c.1965, *Aml* Israel)	1960
Sierra Leone		1960
Somalia		by c.1980
South Africa	1800s	1878
	1902, *Aml*	
Tanzania	1960s, *Aml*	c.1900
Uganda	c.1934, *Aml*	by 1934
Zaire	1932/43, *Aml**	1950
Zambia	1933, *Aml*	1957
Zimbabwe	1932/43, *Aml**	1959
Islands east of (all) Africa, without native honey bees		
Agalega	by 1862	
Mauritius	1934, *Aml* France	)
Réunion		) see Section 36.61
Rodrigues	1981, *Aml* USA	)
Seychelles	bees present by 1768	
Islands west of (all) Africa, without native honey bees		
Azores	late 1400s?, Portugal	
Canary	by 1454, N. Spain	
Madeira	late 1400s?, Portugal	

*Aml**: queens reared in Pretoria, South Africa, introduced between 1932 and 1943 (Fletcher, 1978).

36.43 Ocean islands

These had no native honey bees, and Table 36.4B includes introductions to several islands. European honey bees were probably taken from Spain or Portugal to islands in the Atlantic – the Canaries, Azores and Madeira – during the 1400s (Section 25.33). In the 1600s and 1700s French colonists took African *A. m. unicolor* from Madagascar to Réunion and Mauritius (Section 36.61).

Much farther north in the Atlantic, honey bees could not survive in the wild in Iceland or the Faeroe Islands. According to Matthiasson in 1934, some people were then interested in importing European honey bees to Iceland, and Ólafsson (1979) believed that unsuccessful attempts were made during the 1930s, in Akureyri in northern Iceland and in Reykjavik. In 1951 some were imported by Melitta von Urbantschitsch, a Hungarian, and they survived for a few years (Kristjánsson, 1989). There was probably another attempted introduction after 1960. (Iceland has a native bumble bee, *Bombus jonellus*, which has been preyed on by introduced mink; see Kristjánsson, 1993.)

Paul Skade in Denmark was instrumental in transporting three hives of bees to the Faeroe Islands about 1940; the British were probably involved since they reached the Islands in April 1940 shortly before the Germans (Haack, 1989). The fate of these bees is not known.

36.5 European and Mediterranean races of honey bees to new regions

Between 1850 and 1900 there was widespread activity among beekeepers in trying out new species, races and strains of honey bees. Introductions started before the use of movable-frame hives and were intensified afterwards: it was considered proper to import any honey bees, from any country, since they might prove better than bees available locally. Almost all European and Mediterranean races were tried out in other countries. Between 1891 and 1905 Frank Benton, head of the first US Department of

Agriculture apiculture programme, spent much time travelling in the Old World and transporting honey bees from one country to another, especially to the USA. This activity was widely approved, and an Editorial in *British Bee Journal* (1886) expressed a general sentiment.

> We consider that Mr Benton has conferred the greatest boon possible on bee-keepers in general by his introduction of the Eastern and Carniolan races into this country and America. ... To one who has sacrificed health [Mr Benton was then ill] – and it may be even life itself – for the benefit of our fraternity, we consider a deep debt of gratitude to be due ...

In 1892 C.P. Dadant wrote: 'It behoves our [USA] government to take such matters [importations] in hand for the public good.'

Most queens – transported in a cage or in a colony – would already have mated with drones from a population in the same gene pool, but few records state this. Nor are there references to arrangements in the new area for the mating of queens descended from those transported, although most of the drones present would belong to a different gene pool.

Tables 36.5A and 36.5B list some of the first known introductions of different races into European and Mediterranean countries.

Table 36.5A

Europe: dates of first records found for exotic hive bees (*Apis*), movable-frame hives and *Varroa jacobsoni*

See Table 36.2A for explanatory notes, but in this Table races are named where possible.

Country	*European A. mellifera (or other hive bees) and where from*	*mf hive*	*Varroa*
Albania		1923	yes
Austria	1853, *Aml* Italy		yes
Belgium- Luxembourg	 by 1854, *Aml*		1984 1985
Bulgaria		1887	1967
present Czech Republic	(1866, *cypria*) 1872, *cypria*		1978
Denmark		by 1886	1987
Estonia		c.1880	
Faeroes	c.1940 (?survived)		
Finland	early 1700s, Estonia 1866, *Aml* Italy	1867	1980
France	1858, *Aml* Germany 1863, *lamarckii* Egypt 1874, *intermissa* Algeria c.1886, *cypria, syriaca* 1949, *tAm* French Guinea	1869	1982
Germany	1853, *Aml* Switzerland 1860, *cecropia* Greece 1863, *lamarckii* Egypt 1876, *cypria* present Czech Rep. 1879, *caucasica* Russia by 1930s, *carnica* by 1968, *A. cerana* by 1988, *tAm* Venezuela	1853	1977
Greece		c.1900	1978
Hungary			1978
Iceland	(1930s) 1951	1930s	
Irish Rep.		1874	
Italy		?1863	1981
Netherlands		by 1903	1983
Norway		by 1884	1993
Poland	by 1974, *A. cerana* (c.1970, *tAm*)		1980
Portugal			1988
Romania			1976
Russia (in Europe)	1877, *caucasica* Caucasus 1949, *A. cerana* Primor'ye		1949
Spain		1885	1985
Sweden	1989, *tAm* Tanzania eggs/semen		1987
Switzerland	1843, *Aml* Italy		1984
United Kingdom	1859, *Aml* Switzerland 1867, *lamarckii* Germany 1879, *cypria* present Czech Rep. 1880, *syriaca* ?Syria by 1881, *intermissa* 1886, *tAm* S. Africa by 1886, *carnica* 1962, *anatoliaca*	1861	1992
Yugoslavia (former)	c.1887, *carnica* 1991, *intermissa* Tunisia		1976

36.51 The Italian bee *Apis mellifera ligustica*

This bee is named from Liguria on the west coast of Italy south of Genoa, but honey bees throughout most of the country showed 'a high degree of homogeneity' (Ruttner, 1988). *A. m. ligustica* was the earliest and most widely introduced race worldwide, and Tables 36.2A to 36.5B indicate the first known date of its entry into some individual countries. The story began as follows.

Table 36.5B

Other countries of the Mediterranean region and Middle East: dates of first records found for exotic hive bees (*Apis*) and for *Varroa jacobsoni*

See Table 36.2A for explanatory notes, but in this table races are named where possible.

No known introduction of tropical African *A. mellifera*.

Country	*European A. mellifera (or other hive bees) and where from*	*Varroa*
East of Mediterranean		
Iran		1978
Iraq		1988
Palestine/Israel	c.1880, *caucasica* Germany?	1984
	late 1950s, *Aml*	
Jordan		1991
Kuwait	1958, Australia	
Lebanon	1975, *Aml*	yes
Oman	1600s or late 1700s, *jemenitica* Yemen?	yes
	1976, Egypt	
Saudi Arabia		1987
Turkey		1978
United Arab Emirates:		1988
Abu Dhabi	1978, *carnica* Egypt	
Dubai	1985, *Aml* Australia	
Fujairah	by 1985, *Aml*	
Ras il Khaimah	by 1985, *Aml*	
South of Mediterranean		
Algeria		1981
Egypt	1910?, *carnica*	1989
Libya		1978
Morocco		1989
Tunisia		1978

During the Napoleonic wars, Captain von Baldenstein from Switzerland was impressed by the bees he saw in northern Italy, and in 1843 he got a colony transported across the Alps to his home. He published enthusiastic reports on them in the German journal *Bienenzeitung* (1848, 1851) which Johannes Dzierzon read, and as a result he acquired a colony in 1853.* He wrote in 1861: 'I had in the autumn of the first year twenty-seven Italian stocks, and have since that time sent away thousands of Italian stocks, swarms, and fertile queens, to all the countries of Europe, and even to America.'

In Switzerland Hermann published a book on the Italian bee in German (1859), French and Italian (both 1860). Alfred Neighbour had it translated into English as *The Italian Alp-bee, or, The gold mine of husbandry. Short and practical instructions to breed genuine prolific Italian queens* ... (1860). On 19 July 1859 a consignment of Hermann's bees arrived in England, and queens were reared by both Neighbour and Woodbury. Woodbury (1862) – who assumed that Italian bees were a different species from those in Britain – described this introduction, and his distribution of queens in 1860, including 'one as far as Hull' and another to Scotland. Neighbour (1866) quoted Berlepsch as awarding 'to the Italian a very decided preference over the common bees [north European, *A. m. mellifera*]' for the following reasons among others:

- Italian bees are less sensitive to cold than the common kind.
- Their queens are more prolific.
- They are less apt to sting.
- They are more industrious.

In addition, Italians proved better than north European bees at controlling infestations of wax moth (e.g. Pellett, 1938; Matheson, 1984). A method of introducing a queen from an Italian colony into a colony of British black bees in a skep was described in detail in *British Bee Journal* (1874b).

There were both unsuccessful and successful attempts to introduce Italian bees into North America by Wagner, Jessup and others, and controversies arose about priorities (Pellett, 1938; Naile, 1942; Johansson & Johansson, 1969b, 1970a; Sheppard, 1989). Several leading beekeepers, including Langstroth, tried to import Italian bees from Dzierzon in Germany and from Italy. Success came when 14 live colonies arrived in New York on 22 September 1859; Sheppard (1989) described their subsequent history. Langstroth wrote about breeding Italians (1861b), and he was involved in rearing and selling queens (Watkins, 1968b); Figure 36.5a shows one of his advertisements.

In 1862 Alfred Neighbour sent four colonies of Italian bees in movable-frame hives by the *Alhambra* to Melbourne, Victoria; they reached there in December 'after an imprisonment of 79 days, and have since rapidly multiplied' (Neighbour, 1866). Unsuccessful introductions of Italian bees to Queensland, by James Carroll in 1872 and later, were followed by Charles Fullwood's successful importation of five queens from Italy by 1880 (Weatherhead, 1986). In 1883 Fullwood supplied the South Australian Chamber of Manufacturers with 'a pure colony of imported Italian bees' which was established on Kangaroo Island 13 km off the coast, and further imports came from Naples (Eckert, 1958). In 1885 an Act of the S.A.

*Dzierzon wanted the (yellow) Italian bees as a genetic marker, to obtain evidence for his theory that drone honey bees develop from unfertilized eggs (parthenogenesis); see end of Section 52.61.

ITALIAN QUEENS.

I am now prepared to furnish Italian Queens, bred from the stock imported by Mr. S. B. Parsons, of Flushing, L. I.

Price for an impregnated queen, with a few workers, $10. I am also prepared to guarantee both their purity and safe arrival.

I am authorized by Mr. Parsons to furnish these Bees to Ministers of the Gospel at half-price.

L. L. LANGSTROTH, Oxford, Butler County, Ohio.

June—3m.

Figure 36.5a One of the first advertisements for Italian queens, in *American Bee Journal*, Vol. 1, 1861.

Parliament set aside the island as a breeding station for these bees, and future introductions were prohibited.

From 1879 onwards, Italian bees – mainly from California – were introduced to New Zealand by the Canterbury Acclimatisation Society and by individuals (Thomson, 1922; G.H., 1982). Around 1883 Isaac Hopkins imported 'Italians from Italy, Swiss Alpine, Holylanders, Cyprians, and Carniolans, direct from their respective countries' (Hopkins, 1926).

Hara (1993) found a record that four colonies of European (Italian) honey bees reached Japan from California between September 1875 and June 1876, earlier than the first introductions cited by most authors. Section 36.42 refers to the introduction of Italian bees to tropical Africa, from around 1900. Section 41.5 mentions some other early introductions to Oceania.

From the late 1950s, Israel carried out a systematic programme of replacing the unproductive local *A. m. syriaca* with introduced *A. m. ligustica*.

36.52 Other Mediterranean races

Races from Mediterranean regions outside Europe were the next to be taken to other countries. All had a considerable novelty and excited much interest for a period, but none had such a permanent or important effect on world beekeeping as the Italian. Races are referred to here in order of their first known introduction elsewhere; many dates before 1906 are taken from Buttel-Reepen (1906) who included Gerstäcker's 1862 records. Pellett (1938) and Sheppard (1989) gave details of many imports into the USA. Inclusion of European and Mediterranean races other than *A. m. ligustica* is attempted only in Tables 36.5A and 36.5B.

In 1860 the Greek bee *A. m. cecropia* was sent to Dresden in Germany, but does not seem to have created further interest. The Berlin Acclimatization Society imported the Egyptian bee *A. m. lamarckii* in 1863, and in 1867 it sent queens to Woodbury in England, and to the USA where Langstroth was an active participant in introducing and using it; see Figure 36.5b.

EGYPTIAN QUEEN BEES.

HAVING received choice Queens of this variety from the

BERLIN SOCIETY OF ACCLIMATIZATION,

Which Imports them from Egypt,

WE SHALL BE PREPARED TO

FILL ORDERS FOR THEM NEXT SEASON.

For Circular and Price List send to

L. L. LANGSTROTH & SON,

OXFORD, BUTLER CO.,

November, 1866. Ohio.

Figure 36.5b Langstroth's advertisement for Egyptian queens, in *American Bee Journal*, 1866.

The Cyprian bee *A. m. cypria* was then much sought after by beekeepers. Cori took it to Bohemia (now in the Czech Republic), without success in 1866 and successfully in 1872 and 1874. He transported some to Germany in 1876 and to USA in 1879. Gravenhorst sent others to England in 1879, and Blow imported some direct from Cyprus in 1882. When Benton and Jones were in Cyprus in 1880, they sent still more. In 1880 the Cyprian bee, and the Syrian bee *A. m. syriaca*, were sent by Frank Benton to the USA and by D.A. Jones to Canada, and some also to England. In 1881 Benton introduced the Syrian bee into Sri Lanka and Java (Buttel-Reepen, 1906). In 1887, just before Benton started his sixth journey, he sent Alfred Neighbour in London his catalogue which offered 'a discount of 10% on all cash orders posted before 5 April for Cyprians, Syrians, Palestines, Tunisians'. Benton was about to establish a queen-rearing apiary for Carniolans in Austria, and his 1880 Cyprian apiary was to be enlarged (Johansson & Johansson, 1967b).

Punic (Phoenician) bees, *A. m. intermissa*, were taken to France – from Algeria in 1874 and Tunisia in 1886 – by Baldensperger (1924) who kept them successfully near Nice. These bees were imported into the USA 'some time before 1891' when H. Alley started to rear them for distribution (Sheppard, 1989), and he considered Punic 'the most wonderful race on earth'. However, in the next year Benton castigated them as being 'small, very black and spiteful stingers'. Hewitt kept Punic bees in England for thirty years (Hewitt, 1891; Rotter, 1931). Baldensperger (1924) had also introduced *A. m. lamarckii*, *A. m. syriaca* and *A. m. cypria* into France, probably around 1886.

Schiff and Sheppard's 1993 study of honey bees nesting wild in southern states of the USA showed evidence of a small amount of mitochondrial DNA from a North African race.

36.53 Other European races

Later, the Caucasian and Carniolan mountain races were widely distributed, and remained in use more than any other except Italian. *A. m. caucasica* came from the Caucasus mountains which separate Georgia from Russia. Butlerow introduced them to the Moscow region in 1877, and there were importations into Germany from 1879 onwards (Buttel-Reepen, 1906); queens were sent to Palestine, probably in the early 1880s. The first import to North America may have been by J. Hoffman in Canada. Caucasians were in use in the USA by 1890, and were imported directly in 1903. Benton's visit to the Caucasus region in 1905 led to more extensive imports.

A. m. carnica is named from the Carnic Alps, but its natural distribution includes much of what was Yugoslavia, also Albania, Hungary and parts of Austria, Slovakia and Romania. It was much introduced, and by 1987 Husing and Nitschmann regarded it as the most widely distributed race in the world after *A. m. ligustica*. The first queens in the USA were imported either by Charles Dadant in 1877 or by Alley, who reared Carniolan bees from 1881. From 1883 onwards Benton sent others to Canada and the USA, and they were in England by 1886. *A. m. carnica* evolved to withstand the long and cold continental winters of the Alps, and was of special interest to beekeepers in northern countries. During the 1900s it became well established in Norway, Russia and Canada, and since the mid-1930s beekeepers in some central European countries carried out a continual replacement of local bees by *A. m. carnica* (Ruttner, 1988). The bee was also chosen for a national German replacement programme in the 1930s (see Crane, 1990a), partly because of the rapid development of colonies in spring. Morphometric measurements around 1990 in Lower Saxony showed that the bees then present were much influenced by *A. m. carnica*, but that a gene contribution from the native population remained (Bienefeld, 1988; Reinsch *et al.*, 1991). Except on an island, such a replacement programme must be maintained indefinitely, because queens near the boundary can mate with drones from outside.

Between 1950 and 1977 Brother Adam took queens of selected honey bee races from many parts of Europe and Mediterranean regions to Buckfast Abbey in England, for use in his breeding programme (Adam, 1968, 1983).

In 1966/67 a national bee breeding project was carried out in Egypt, to replace the native *A. m. lamarckii* by the more productive and manageable Carniolan; this bee was chosen because the different body colorations provided a genetic marker which showed up progeny of any mismatings of new queens with *A. m. lamarckii* drones, and such queens could be killed. Body colour was also used to detect remnant populations of dark northern European bees in regions or islands in the Americas where Italians later predominated. *A. m. iberica* from the Iberian peninsula, the first honey bee in South America (Nogueira-Neto, 1964, 1967), was also dark.

During and after the 1970s new methods for studying the genetics of samples of honey bees were developed, including enzyme analysis using electrophoresis and mitochondrial DNA restriction fragment analysis, which can help to establish the geographical origin of honey bees introduced to different regions in past centuries.

36.6 Tropical African honey bees to new regions

So far as is known, tropical African honey bees have not been introduced to Asia, or to Australia, although occasional swarms reached there on ships, and have been intercepted and destroyed.

36.61 African islands and mainland

Honey bees from Africa south of the Sahara were transported to other parts of the mainland and also to neighbouring islands. The first honey bees taken to São Tomé, 300 km off the coast of the Gulf of Guinea, were probably *A. m. adansonii* from the mainland, but European *A. mellifera* was introduced later, and the situation may be compared with that in South America (Peterson, 1980); see Section 36.63.

A. m. unicolor is native to Madagascar east of Africa. Bees on the coast have tropical characteristics, whereas those in the highlands are more similar to Europeans (Ruttner, 1988). *A. m. unicolor* was taken to Réunion in 1666 and to Mauritius in 1721, both previously without honey bees (Campêche, 1973). Ratia (1984) quoted the journal of a 1768 French expedition to the Seychelles: 'we saw bees but no hives.' Silberrad (1970) said that in the Seychelles 'black bees of European origin were probably introduced via Mauritius, to which they were probably brought by the Portuguese sailing ships'. But the early bees in Mauritius were *A. m. unicolor*, and a preliminary sample studied by Ruttner (1993) showed 'close relations between the bees in the Seychelles and *A. m. unicolor* in Madagascar and Mauritius, although they were distinctly smaller'.

During evolution the Cape bee (*A. m. capensis*) became adapted to the Mediterranean climate in the extreme south of Africa. It has a most unusual characteristic: although the workers cannot mate, they can lay diploid eggs from which their colony rears females, including fertile queens. In early times, the Karoo desert separated *A. m. capensis* from *A. m. scutellata* farther north, but from 1927 onwards beekeepers sometimes moved colonies of *A. m. capensis* to Pretoria and elsewhere in *A. m. scutellata* territory. In such circumstances a Cape worker might enter a colony of *A. m. scutellata* and produce queen pheromones, so the colony treated her as a queen; she superseded the existing queen, and the whole colony became one of *A. m. capensis*. In the early 1990s a '*capensis* invasion' extended from the Free State to most of the Transvaal and parts of KwaZulu Natal. Allsopp (1992) told the story and discussed ways of counteracting the '*capensis* calamity'.

36.62 Europe

Tropical African bees were sent to Europe from the late 1800s, but probably did not survive the winters. In 1885 Dr J.W. Stroud in Port Elizabeth, Cape Province, South Africa, offered to exchange queens with beekeepers abroad. He considered his 'South African bees' superior, and wanted to introduce them to Britain; he had two distinct varieties, yellow and black – probably *A. m. scutellata* and *A. m. capensis*. In 1886 he offered to sell queens to A.I. Root in the USA; he also said that they were being offered for sale through the *British Bee Journal*, and indeed G. Walker (1886) in England received a nucleus colony safely. Tyrrell (1889), in East Griqualand west of Durban, wrote 'I sent some home once' – probably *A. m. scutellata* – and there were other such enterprises.

Not everyone was enthusiatic about the tropical African bees. Betts (Bee World, 1949a) reported an account by Mathis of his recent importation into France of traditional hives of bees from French Guinea, which would have been *A. m. adansonii*; she did not share the belief that these bees would be suitable for increasing the bee population of Europe. Even if they were 'interfertile' with *A. mellifera*, she expected the hybrids to be bad winterers and very vicious. Woyke (1973b) kept about 30 colonies of '*A. m. adansonii* [?*A. m. scutellata*]' in Poland in the early 1970s. They did not survive the long cold winters, but queens he introduced to colonies of European *A. mellifera* in autumn did so.

In 1987 Brother Adam went to Tanzania to obtain queens of *A. m. monticola*, a race which lives at high altitudes on Mount Kilimanjaro; selected queens were sent to Buckfast Abbey, but were all dead when they arrived a week later (Bill, 1989). In 1989 eggs and semen of *A. m. monticola* from Mount Elgon were taken to Sweden, for use in experiments on the development of resistance to *Varroa* infestation. Queens were reared from the resulting colonies, and various crosses were made. Tests on *Varroa* resistance were conducted mainly on the Baltic island of Gottland; a commercial strain Elgon® was developed and registered in Sweden, with various genetic contributions from Buckfast strains and from *monticola* (Österlund, 1991, 1993).

For introductions of Africanized bees into Europe, see Section 36.64 and Table 36.5A.

36.63 The Americas: 1956 introduction and its consequences

Transport of honey bees from tropical Africa to tropical America had far-reaching results. In 1956 W.E. Kerr and his associates had made a search in South-

ern Africa for honey bees that might do better in Brazil than the European bees introduced earlier (Kerr, 1957). He succeeded in bringing 62 queens of *A. m. scutellata* and one of *A. m. capensis* alive to Piracicaba, S. Paulo, at 23°S in the Brazilian tropics. Of these, 48 queens from South Africa and one from Tanganyika were successfully introduced to colonies of European bees, and some of these became 'the most prolific, productive and vigorous' that Kerr had ever seen.

In 1957, queen excluders were inadvertently removed from the entrances of 26 colonies, which soon swarmed. African drones mated with queens of European bees either nesting wild (Gonçalves, 1974) or produced in apiaries (Ramirez, 1993). Progeny of the introduced bees were referred to by beekeepers as 'Brazilian' or 'Africanized' bees, and the latter term is used here to distinguish them from bees in tropical Africa. Large numbers of African or Africanized queens were distributed in the late 1950s and early 1960s (Spivak *et al.*, 1991), and these bees became the predominant type in spite of the wide distribution of Italian queens in the 1960s. Ramirez (1993) quoted various published versions of events, and gave details of other transportations of the progeny of introduced African queens.

The Africanized bees formed a population that displaced European bees in the immediate neighbourhood, and in a continually increasing area, from which the bees spread further by reproductive swarming and absconding; in the tropics the 'front' advanced 300 to 500 km a year (Taylor, 1977); see

Figure 36.6a Map showing the rate of spread of Africanized bees in South, Central and North America (based on Crane, 1990a).

Figure 36.6a. Within thirty years Africanized bees became established in parts of all countries of South and Central America except Chile. The bees did not always survive at high altitudes, and their southward spread was limited by the cooler climates there. The sequence and mechanism of this spread of Africanized bees has been told many times (e.g. Gonçalves, 1974; Taylor, 1977; Kent, 1988), and Tables 36.2A, 36.2C and 36.2D give the year in which the bees were first reported in different countries.

In the Caribbean, Africanized bees have been reported only in Trinidad, which they reached from Venezuela during and after 1979; promontories in Trinidad reach to within 15 and 19 km of Venezuela, and there are small islands in between. The bees have apparently not reached Tobago 50 km NE of Trinidad.

Africanized bees spread northwards from South America through Central America, and into Mexico in 1986. Alarm in the USA grew, and was increased by the arrival (between 1979 and 1990) of twenty isolated colonies or swarms identified as Africanized, on ships or their cargo arriving in the USA from the south (Thomas & Sheppard, 1990); in California a colony – probably from a ship – was found nesting in 1985 and was killed. A joint programme to slow down the spread of Africanized bees in Mexico was conducted by the Mexican and US Departments of Agriculture, and may have had a temporary effect. But in October 1990 a swarm of Africanized bees was recorded north of the Mexican border, at Hidalgo in Texas. By mid-1993, 53 counties of southern Texas were 'regulated' because of the presence of at least one Africanized colony (Wilson, 1993). Also in 1993, Africanized bees were in Arizona by July and in New Mexico by November; by 1994 they were in California.

In Louisiana, Taber (1961) in the United States Department of Agriculture had developed a method for transporting honey bee semen, and it became possible to inseminate queens with semen transported from other continents. Kerr sent semen from Brazil, and 3 of 5 queens inseminated with it produced offspring; semen used for one of these queens was from descendants of the African queens taken to Brazil in 1956 (Morse *et al.*, 1973). In 1960 and 1961, Kerr sent Taber many shipments of 'pure African' honey bee semen, which together contained sperm from a large number of 'African' drones, and Taber (1977) maintained a few colonies of various African hybrids for 3 or 4 years. Since the 1960s there have been suggestions of other introductions into the USA, and discussions as to possible effects of these (e.g. Wilson & Menapace, 1979; Miksa, 1986). Kulinčević *et al.* (1984) made extensive tests to find out whether an increased bee mortality of colonies – reported especially in the late 1970s – was due to genetic differences, and they found no evidence for this.

The introduction of the tropical African bee to the Americas in 1956 became a contentious issue, and many reports were published on Africanized bees, some scientific and others uninformed and emotive. A book edited by Spivak *et al.* (1991) gave much information, and Winston published a shorter account (1992).

36.64 Africanized honey bees to Europe

Some scientists in Europe made introductions at experimental stations in order to study the biology and behaviour of these bees. For instance by 1988, Africanized *A. mellifera* bees from Venezuela, referred to as *A. m. scutellata*, had been imported into Germany. They, and hybrids with the local *A. m. carnica* bees, were used at Oberursel for experiments on the resistance of bees to the *Varroa* mite. Many German beekeepers objected to the importation and, in response to representations from beekeeping organizations, the six colonies with imported Africanized queens and five with hybrid queens were destroyed in February 1989 (Maurer, 1989). Some known introductions are entered in Table 36.5A, and a number of others were probably made.

36.7 Asian honey bees to new regions

There have been attempts to introduce *A. cerana* outside its native area (Figure 3.2a), for beekeeping or for research purposes. Section 36.11 mentioned a possible transport from the lower Indus valley to Persia (Iran). Maa (1953) quoted an undated statement by M.A. Lieftinck: 'I believe that the species has been introduced in these islands [Saparua, south of Seram, in Indonesia] long ago, perhaps more than a century.'

In the late 1950s Kerr imported *A. cerana* from Hong Kong to Brazil, but it did not become acclimatized there (Nogueira-Neto, 1967). In 1968 Ruttner and Kaissling reported field experiments with *A. cerana* in Oberursel, Germany, and in the 1970s colonies were imported from both China and Pakistan to Germany for experimental purposes. Woyke (1973a, 1979) kept colonies of *A. cerana* in Germany and Poland.

In 1985/86 *A. cerana* was taken from another Indonesian island to Irian Jaya (part of New Guinea), and by 1987 it reached Papua New Guinea where

D.L. Anderson (1989) traced its spread eastward. By 1993 it was found on islands in the north part of the Torres Strait. Australian beekeepers were very concerned that it might cross the Strait to the Cape York peninsula, and thus destroy Australia's *Varroa*-free status which was valuable to the country's queen export industry (Bee World, 1993).

One of Benton's aims in his voyages in Asia was to take to USA some colonies of the 'superior' *A. dorsata* from south-east Asia. In 1899 he published corrections to earlier reports on his travels around 1880: 'I secured four colonies of *Apis dorsata* which I brought with me alive eighteen days on the journey to Syria by fast steamer.' However, he was ill on his voyage home to the USA, and all the bees died (Pellett, 1938). A colony of *A. dorsata* was successfully transported by G. Dathe to Germany in 1883 (Buttel-Reepen, 1906) and another by Jones to Australia in 1899 (Ruttner, 1988).

The extension of the range of *A. florea* within the Persian Gulf area may possibly have been aided by man (Section 36.11), and two recent westward movements certainly were. Colonies were found in the Khartoum area of Sudan in Africa in 1985 (Lord & Nagi, 1987; Mogga *et al.*, 1989), and in the Riyadh area of Saudi Arabia in 1988 (Al-Ghamdi, 1990). The colonies multiplied rapidly in both these hot dry regions. The transport was presumably by air, but it is not known where the bees came from.

In addition to the above, enclosed flight rooms were developed for honey bee colonies in 1972, and research workers in Germany (e.g. N. Koeniger, 1977; Engels, 1977) subsequently imported and reared colonies of *Apis cerana*, *A. dorsata* or *A. florea* in them.

36.8 Transport of bees other than honey bees

36.81 Stingless bees

Stingless bees occur widely throughout the tropics (Figure 3.2a). The first colonies of bees taken by ship to Australia are likely to have been stingless bees, although they were regarded as honey bees. On 1 December 1809, on board the *Ann* between Rio de Janeiro and Sydney, the Rev. Samuel Marsden wrote: 'I have seven Spanish sheep with me on board ... Two Hives of Bees I found in Rio and shall attempt to take them out. The Gooseberry and Currants I took from England are also alive and I think I shall get them out.' On 4 May 1810 he added from Parramatta, NSW: 'I have got in a very fine state the Gooseberry currant and vine. I also took out two hives of Bees from Rio and got them out safe but am afraid that many of them are dead since ... I left them in the Governor's garden, where I fear the heavy rains have injured them' (Marsden, 1942). Nogueira-Neto (1964) presented evidence to show that there were no honey bees in Brazil before 1839 (Section 36.25), whereas Marsden could well have found stingless bees in Rio.

During the 1800s other European travellers who encountered stingless bees in the tropics had an urge to take them home and try to rear them. In Captain Beechey's *Narrative of a voyage to the Pacific and Bering Strait* published in 1831, Bennett described two hives of *Melipona beecheii* that the expedition took to London from Mexico. During the same period, a nest of live stingless bees was occasionally found in Europe when timber imported from tropical forests was sawn up. In London, Bigg (1834) exhibited live bees of 'a very pretty and apparently undescribed' species of *Trigona* that originated in Brazil. Schwarz (1948) cited later examples, and discussed the bees' long survival without provision of food; some of the nests were over a year in transit.

Paris became the centre of practical interest in stingless bees (Darchen & Louis, 1961). In France, Latreille and Lepeletier had laid the foundation of the systematics of Meliponinae in the early 1800s, and Blanchard (1849) made what was possibly the first attempt to maintain colonies of stingless bees there. Two colonies were brought from Rio de Janeiro; one (*Trigona (Trigona) pallida*) soon died, but the other (*Melipona quadrifasciata anthidioides*) survived from May until September. From 1871, Drory – then living in Bordeaux – received many colonies from Bahia in Brazil. In 1873 he had 21, representing 11 species; only two colonies survived the winter, after which one died in April and the other was 'very weak' by September (Drory, 1874). About 1870 the Société Impériale d'Acclimatisation offered a prize of 500 francs to anyone who could maintain a colony of stingless bees for two years. No one succeeded, so Raveret-Wattel – who had initiated the enterprise – collected information on keeping stingless bees and published it in 1875. Wintering the colonies was the insoluble problem, and the prize was never claimed; it lapsed after 1890.

Unsuccessful introductions were made to other temperate-zone countries, including Germany in 1875 and 1905, USA in 1886 and 1905/07; also England from the Americas (above) in 1831 and 1834, and from Asia in 1900 and 1903 (Schwarz, 1948). Success was finally achieved in 1966 in Japan, by Sakagami who housed each colony in a heated box. Unlike honey bees, stingless bees do not need to fly

out to defecate, and if a colony is continously supplied with food it can be kept in an enclosed environment. However, queens and drones must fly in order to mate, and there was little success with mating from colonies reared in confinement.

36.82 Bees for pollination

The history of worldwide transport of non-*Apis* bees to be reared for pollination is told in Sections 45.4 and 45.6. From 1885 onwards, bumble bees were successfully transported from England to New Zealand for pollinating red clover, and in 1982/83 some were taken from New Zealand to Chile for the same purpose. Since the mid-1980s, when *B. terrestris* was first used for pollinating greenhouse tomatoes in western Europe, other possibly useful species were sought and some probably imported.

Two solitary bees now used for pollination of alfalfa (Section 45.62) were transported between continents. *Megachile rotundata* was accidentally introduced to the east of North America from Europe or Turkey some time before 1937 when it was found in Virginia (Stephen & Torchio, 1961). The climate suited the bee, which spread across the continent and reached the western seaboard twenty years later. In 1962 it was imported directly into western Canada – whence it was exported to New Zealand in 1971.

In western Canada in 1965, I saw the rearing of *Nomia melanderi* which had just been introduced from an area of alkaline soil in western USA. The bee was taken to New Zealand in 1971.

36.9 Damage caused by the transport of honey bees

When European *Apis mellifera* was taken to some regions inhabited by social bees with a smaller body size and/or colony size (e.g. stingless bees) and the new bees did well, they could out-compete the native bees for forage or, less commonly, for nest sites. In some parts of Australia, populations of stingless bees and of native flora pollinated by them were reduced by the presence of *A. mellifera*. In many parts of Asia the native *A. cerana* survived only in uncultivated areas where introduced *A. mellifera* found insufficient forage. After African *A. mellifera* was transported to South America in 1956, in many areas the resulting Africanized bees displaced existing populations of the less dominant European honey bee (Section 36.63).

If honey bees carrying an infectious disease or a mite infestation, or with wax moth on their combs, were transported to a new area, colonies of bees there often suffered severe damage. This might remain undetected until some colonies died, whether in hives or natural nests, and by then many others had become infested. Since the early 1800s, the greater wax moth (*Galleria mellonella*) had been inadvertently introduced and spread throughout the USA (Section 38.4), resulting in the infestation of many colonies, and one response by beekeepers was to import Italian bees (Section 36.51) which are better able to resist wax moth infestation. Introduced American foul brood disease caused much damage to colonies in the 1880s.

The USA and Canada enacted legislation in 1922 and 1923, respectively, to prevent the import of honey bees and hence of 'Isle of Wight' disease. This disorder had caused wide concern in Europe, and was believed to be due to infestation by the tracheal mite *Acarapis woodi*, identified in 1921 (Table 52.7A). In 1959 Jeffree estimated which world regions had a climate enabling *A. woodi* to survive if it was introduced; these included parts of Argentina and of northern India, where the mite had in fact been present since 1951 and 1957, respectively, and also parts of eastern USA which it reached by 1984.

During the late 1900s it was increasingly realized that infectious diseases, parasitic mites and undesirable genetic characters could be transmitted by the transport of bees. By the 1980s a number of honey bee diseases and parasites were present in 138 countries; surveys by Nixon (1982), Bradbear (1988) and Matheson (1993, 1996) show those recorded in each country by the dates of publication. By 1990 sixty countries had enacted legislation to regulate the importation of bees; they were listed by Crane (1990a). One result was that isolated islands such as Hawaii became increasingly important as suppliers of packages and queens, sent by air freight. Legislation was extended to honey which could transmit viable spores of *Bacillus larvae* (American foul brood), and to used combs which might be contaminated with *Nosema apis* spores.

The mite *Varroa jacobsoni* parasitized *A. cerana*, probably since evolutionary times, but the mite and its host co-existed. In the Pacific Primor'ye province of the USSR, the mite transferred to introduced *A. mellifera*, which had not evolved with *Varroa* and was much more damaged by it. Beekeepers did not realize this, and when air transport became available many *A. mellifera* queens and workers were sent by air from Primor'ye to Moscow, some of them infested with *Varroa*. From the 1960s onwards the mite was transmitted to almost all other European countries

(Crane, 1978c), usually by the transport of parasitized *A. mellifera*. It reached Paraguay in South America by 1975 and North Africa by 1978, and Niger in tropical Africa by 1991. The *Varroa* mite was spread around the world almost entirely by direct human action. Tables in this Chapter give the date of the first documented finding in individual countries (Matheson, 1995, 1996), which can be some years after its first arrival. The mite may also have reached other countries, especially neighbours of those where it is recorded. In Asia, it is endemic as a parasite of *A. cerana*.

37

History of Observation Hives

37.1 Observation hives in the Ancient World

A belief, probably unfounded, that Aristotle made an observation hive, is first known from an encyclopaedia of animals by al-Damiri Kamal al-Din who died in 1405. This related that the bees, 'indignant at his prying', obscured the glass with clay; according to Blum (1955) a somewhat similar story was told about Solomon. (Honey bees would not use clay, but might deposit wax or propolis on hive walls, thus reducing their transparency.)

Pliny's *Naturalis historia* made two references to transparent hives, and described in detail the development of immature honey bees in their cells (Section 52.43) observed 'on the suburban estate of a certain ex-consul in Rome, who had hives made of the transparent horn of a lantern' (XI.16.49). Later, after listing three types of hive he added that 'many too have made hives of transparent stone, so that they might look on the bees working inside' (XXI.47.80); it has been suggested that this material was mica. Pieces of horn or mica could, with difficulty, have been inserted in the end or side of a hive of cork bark, woven osiers or *Ferula* stems, which Pliny mentioned.

37.2 Hives in which the bees could be seen through glass

Flat glass was produced in Lorraine and Normandy in France, in small sheets during the 1500s and in larger sheets by the late 1600s. Wood was needed to fuel the glass furnaces, so when supplies were ex-

Figure 37.2a John Evelyn's drawing of his 'glass hive', c 1655; Dr John Wilkins gave him the hive in 1654 (D.A. Smith, 1965). The handwritten key includes the notes

ABCD the Hive or Box of an octagonal form.
E the convex ledge.
F the Doores for the bees to go in and out.
L the Stoole.
M the pedestal.
N the Roofe or Dome to be set upon the upmost hive.

hausted at one place the glass workers had to move to another, and many French workers went to England where coal was used from 1610.

Mew (1653a) made 'transparent' hives so that he could watch his bees: 'I can take a strict account of their work, and thereby guesse how the rest prosper ...' The earliest known description of the use of flat glass in observation hives is in John Evelyn's *Elysium Britannicum*, written about 1655 but not published for over three centuries (D.A. Smith, 1965). Evelyn described the octagonal hive of wood shown in Figure 37.2a; 'in the side opposite to the quarter where the holes or doors are, let there be a Window to open with hinge, with lock and key. This may be about four inches broad and six high [10 x 15 cm], within which fix a piece of Normandy glass exquisitely cemented, to look in upon all occasion.' In his diary for 13 July 1654 (De Beer, 1955) Evelyn wrote:

> We all din'd, at that most obliging and universally Curious *Dr. Wilkins's*, at Waddum [Wadham College, Oxford], who was the first who shew'd me the *Transparent Apiaries*, which he had built like *Castles & Palaces* & so ordered them one upon another, as to take the *Hony* without destroying the *Bees*; These were adorn'd with a variety of *Dials*, *little Statues*, *Vanes* &c: very ornamental,* & he was so aboundantly civill, as finding me pleasd with them, to present me one of these *Hives*, which he had empty, & which I afterwards had in my Garden at *Says-Court*, many Yeares after; & which His Majestie [Charles II], came on purpose to see & contemplate with much satisfaction.

Samuel Pepys wrote similarly in his diary for 5 May 1665.

> After dinner to Mr. Evelings: he being abroad we walked in his garden, and a lovely noble ground he hath endeed. And among other rarities, a hive of Bees; so, as being hived in glass, you may see the Bees making their honey and combs mighty pleasantly.

On the left of Figure 37.2a, above a small faint drawing, is the note: 'Describe Hives all Glass, and Top only glass with wooden Cover ...' However, in England large sheets of glass were not produced until about 1670 (Singer *et al.*, 1954/58), and plate glass later still, so it seems most unlikely that Evelyn ever had a hive that was 'all glass'. In 1657 Robert Wood said that the transparent part of Dr Wilkins's hive was only 'a peece of glass a little bigger than my hand set into the Hive on one side'. The first reference found to a glass hive – as distinct from a wooden one with glass windows – was by Richard Blome in *The gentleman's recreation* (1686).

In Amsterdam, Swammerdam's detailed drawings of bees seen under a microscope were made between 1669 and 1673. They were published in 1737/38, and according to Réaumur (1740) the work could not have been done without using glass hives. Swammerdam's book made no reference to them (van Laere, 1991), but the requisite glass would have been available to him, and also to the Honourable Robert Boyle, Irish chemist and physicist, who had in his closet (1688) 'a Transparent Hive, whence there was a free passage into a Neighbouring Garden'. He marvelled to see the bees 'at work about making their Combs, and filling them with Honey. ... it were hard for a Mathematician, in contriving so many cells as they make in the area of one of their Combs, to husband so little space more skilfully, than they are wont to do, and not only they carefully and seasonably lay up their Honey to save them all the Winter, but curiously close up the particular Cells with covers of wax, that keep the included liquor from spilling and from external injuries.'

The Italian astronomer Maraldi, who moved to Paris about 1687, was also interested in bees, and the 1712 account of his observations referred to a large number of glass hives (*ruches vitrées*) in the garden of M. Cassini which adjoined the Paris Observatory. In 1740 Réaumur published Volume 5 of his *Mémoires pour servir à l'histoire des insectes*, which described his important observations on bees and referred to Maraldi's statement above; he probably did not know of Boyle's 1688 publication or of the hives used by Wilkins and Evelyn in 1654. He discussed glass observation hives at some length, all of which accommodated several combs side by side. The book included scale drawings of his simplest observation hive (Figure 37.2b) and of a larger one about 120 x 120 x 17 cm, with only the front of glass. Several differently shaped hives were made up of tiered boxes with large glass window panes protected by hinged wooden doors (Figure 37.2c).

Scientists mentioned in later Chapters who used observation hives in the 1700s include Spitzner in Germany (1788), Vicat in Switzerland (late 1700s), and Hunter in England (1792). A variety of other people watched bees in glass hives. In England Warder (1712) kept bees in 'transparent Boxes', and

*It seems to me likely that the structure Evelyn described (Figure 37.2a) was similar to the 'innocent Phancie' Mew wrote about in 1653 (Section 40.2), and that Dr Wilkins copied this as well as the hive from Mew's design.

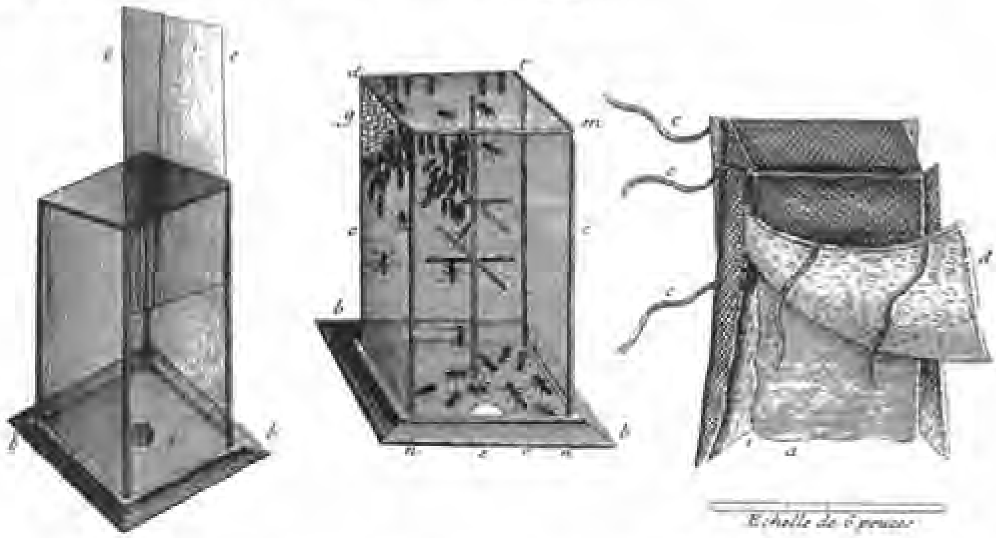


Figure 37.2b Réaumur's small glass hive (18 x 11 x 11 cm), used for observations and experiments (1740). *left* With front lifted up. *centre* With front closed; cross-sticks to support combs have been inserted, and the bees have started to build in one corner. *right* Insulated cover for the hive.

in 1722 Macky reported that in the large kitchen garden at Canons, near Stanmore in Middlesex, 'there are bee-hives of glass, very curious' (Hadfield, 1969). In London Hoy (1788) advertised 'Bar and Glass Bee-hives'; his illustration (Crane, 1975c, Plate 15) showed an octagonal hive with large windows in the sides, and bell glasses on top, as in Figure 38.3d. A handbill advertising an exhibition in Hull on 9 October 1812 offered 'Six Beautiful Glass Bee-Hives, with their appendages, containing a complete Swarm in each Hive ... so arranged that the Spectator can at one View fully comprehend the truly Wonderful Order, Contrivance, and Harmony, that pervades this astonishing Community ...'. The prices for admittance were 'Ladies and Gentlemen, One Shilling each, Servants and Children Sixpence each'.

Small observation windows like those described earlier were subsequently fitted to skeps, and to many types of wooden hives, with or without movable frames. Langstroth (1857) used full-size frame hives with two or more glass walls. L.C. Root's 1879 revision of the book by Quinby, his father-in-law, showed an 'observatory hive' with two sides of glass framed in wood.

37.3 Huber's leaf hive without glass

François Huber was born in Geneva, Switzerland, in 1750, and his sight started to fail when he was only 15. He was more or less blind all his adult life, and his many observations and discoveries on bees were made with the devoted help of his wife Maria, his assistant Burnens and, later, his son Jean Pierre. The posthumous 1841 English edition of his book *Nouvelles observations sur les abeilles* (1792) included a short biography and described his search for a type of hive that would allow better observation of the bees' activities than had been possible for his predecessors. So that he could study the bees on both

Figure 37.2c Glass hives shown on the first text page of Réaumur's 1740 book. The engraving also shows three skeps, two swarms, and a beekeeper taking one of them.

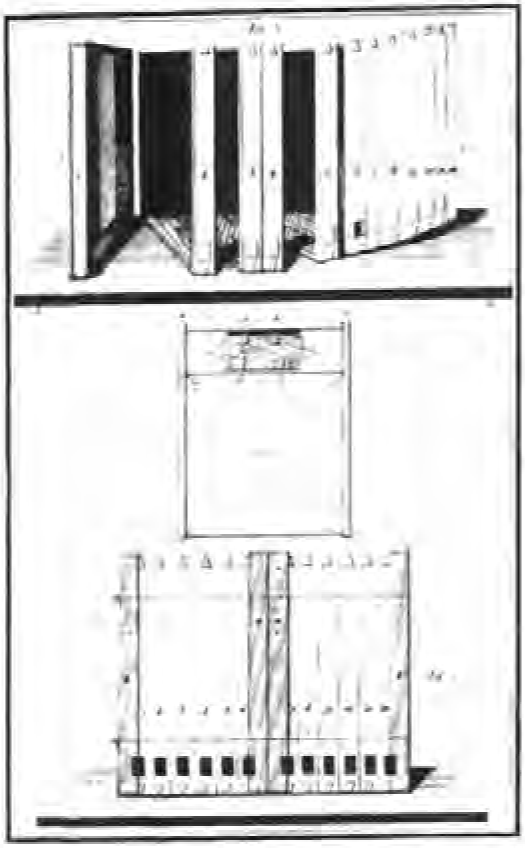


Figure 37.3a Drawing of Huber's leaf hive (1792). See text for details. The bottom drawing shows the closed hive.

sides of a comb he experimented with single-comb hives (Section 37.4), but he felt that they were unnatural for the bees. So he devised a *ruche à feuillets* or leaf hive (Figure 37.3a), consisting of 12 wooden frames (30 cm square and 32 mm thick) hinged together along one of their upright sides, so that any adjacent two could be parted at an angle like the leaves of a book – hence the name.

To populate a hive, a piece of comb was first fixed within the small upper part of each frame (Figure 37.3a, centre). Then bees were put in, and the hive closed until they had secured each of these combs to its frame; they would then build comb in the lower part of each frame as well. The hive was made in two halves, which Huber could separate by shutters on frames 6 and 7 if he wanted to divide the colony into two.

> Opening the different divisions in succession, we daily inspected both surfaces of every comb; there was not a single cell where we could not see distinctly whatever passed at all times, nor a single bee, I may almost say, with which we were not particularly acquainted.

Both patience and dexterity were needed to close the opened frames together again without crushing any bees, and few people since Huber seem to have used this type of hive. In 1882 F.V. Hadlow's variant won first prize for the best observation hive at the Royal Counties Show at Brighton in England. Adjacent frames were hinged in pairs along opposite upright sides, so that they could be pulled out of the hive horizontally – in a zigzag pattern – into a long extension fitted to the hive, both of which were made of glass (Herrod-Hempsall, 1937).

37.4 Single-comb glass observation hives

Much of our recent knowledge of bee behaviour within the colony has been obtained by using a glass hive containing a single comb or an array of them, allowing bees to be observed on both sides of each comb, which was impossible with any hive described so far except Huber's. Such a hive needs shutters outside the glass to reduce heat loss from the exposed comb surfaces. Exactly the correct spacing must be provided between the comb surface and the glass wall: if it is too small the bees cannot move over the comb, and if it is too large they deposit wax over the glass as if this were the surface of another comb. The history of the development of these hives is as follows.

Huber wrote in a letter to Charles Bonnet on 13 August 1789 (published in 1792):

> Glass hives constructed after M. de Réaumur's principles are of a form unfavourable to the observer; because their width allows the bees to build two combs parallel, whatever passes between them is concealed from view. Long experience of this has induced you to recommend hives much flatter or thinner; the panes of which should be separated by so small an interval that only a single row of combs could be erected between them. From having felt the same inconvenience, I have profited by your counsel in providing hives reduced to an inch and a half [38 mm] in width, wherein swarms have been established without any difficulty.

Huber did not quote all the dimensions of this single-comb hive, which he rejected in favour of his 'leaves', but in 1810 Feburier described such a hive, 45-60 cm high and 30-45 cm wide, with uprights and a cross-bar at the top about 50 mm thick and 33 mm broad. 'This breadth, being sufficient to admit of the bees constructing a comb, forms almost the whole

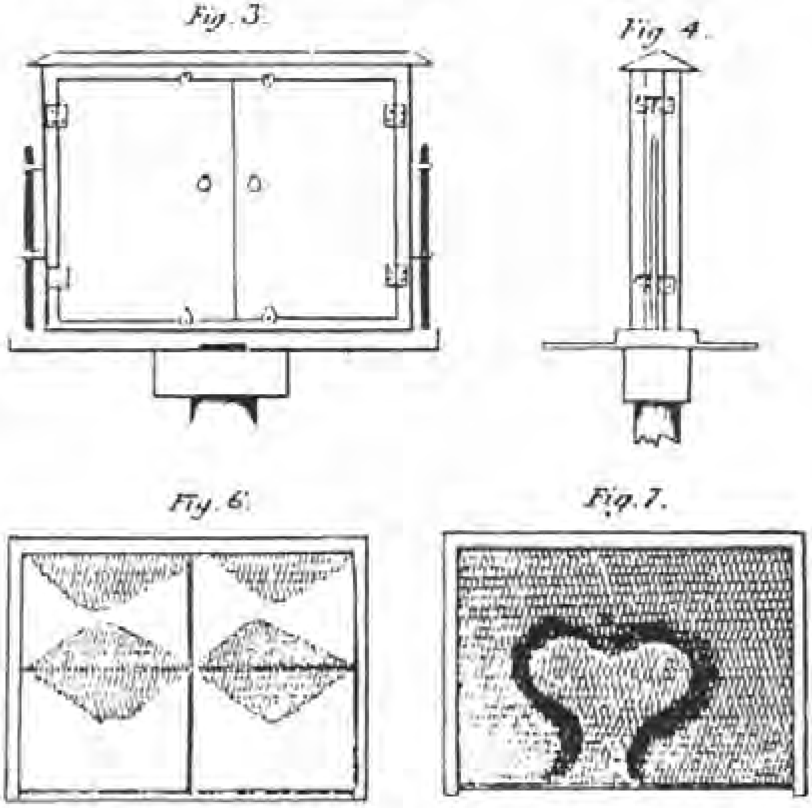


Figure 37.4a Earliest known drawing of a single-comb observation hive (Dunbar, 1820).

Fig. 3 Hive with shutters closed, mounted on a turntable.
Fig. 4 End view.
Fig. 6 Hive after comb building commenced.
Fig. 7 Fully built comb; shaded area shows pollen stores round the edge of the brood nest.

interior of the hive.' Panes of glass, mounted in a wooden frame not more than 13 mm thick, formed the sides of the hive which was 20 lines from back to front internally: 12 for the thickness of the comb and 4 on each side for the passage of the bees (20 lines = 42 mm).

The Reverend William Dunbar in Scotland was successful with a similar hive, which he described and illustrated in 1820 (Figure 37.4a). It contained 'only one comb, and glazed on each side; the whole swarm [colony] therefore, half on each side of the comb, was exposed to my view; not a single bee escaped my notice, nor could even Majesty itself be secure from my observation'. Whereas Huber had found difficulty in getting the bees to build a single comb exactly *along* the hive, Dunbar succeeded by inserting a horizontal rod along the hive, half way up (Figure 37.4a, Fig. 6). The bees then started building comb down from the rod and also up from it, and down from the top of the hive, so that 'two combs were going on at once, which eventually became one', and 'in 4 days or less, the upper comb and this middle piece met, and the whole separate parts were joined'. In England Bevan (1838) described results Dunbar obtained with his hive, and gave details of his own 'unicomb hive', together with that of Golding whose book was not published until 1847.

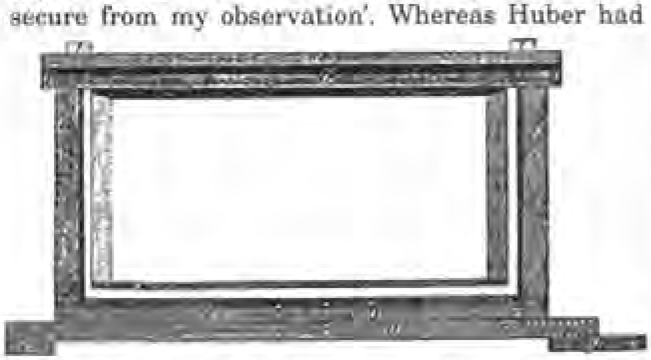


Figure 37.4b Parlor-Observing Hive containing a frame (Langstroth, 1857).

From the 1850s when movable-frame hives were used, it was easy to transfer a frame or frames, with the queen and bees, from a normal hive to a single-frame observation hive. Langstroth expounded on the advantages of doing this, and Figure 37.4b shows the hive he published in 1857. In England, the 1878 edition of Neighbour's book illustrated a hive holding an array of four or six Woodbury frames (Figure 37.4c). At the Bath and West of England Agricultural Show in 1863, he had exhibited the hive; the bees left and entered through a passage covered with glass, 'and the sight of them very much enhanced the interest of visitors'.

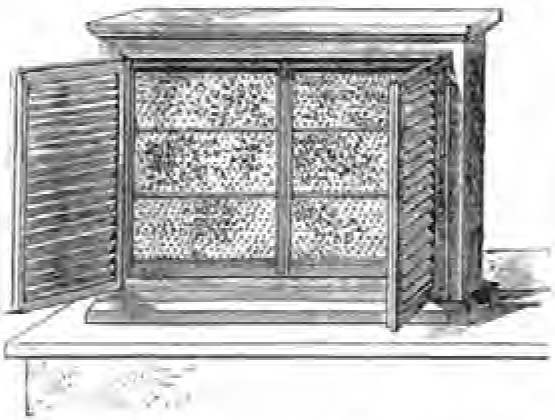


Figure 37.4c Woodbury 'unicomb hive' (Neighbour, 1866). Outdoor design for 6 frames, having doors 'fitted with shutters composed of Venetian blinds'.

Many important observations were made on honey bees in the 1900s using hives on the same principle. The most widely known, in the 1920s and 1930s, were by Karl von Frisch on 'communication dances' by bees after they return from foraging (Section 52.53). Figure 37.4d shows one of his hives, described with others in his 1965 book.

Further movable-frame observation hives have been made with facilities for heating and temperature control (necessary with a large array of combs), or for easy removal of an individual frame or an individual bee, or for other operations. Showler (1985) showed examples, and Crane (1990a) gave references.

Figure 37.4d One of the observation hives used by K. von Frisch (1965), which held two standard German frames. 1 Flight entrance. 4,5 Inner and outer glass windows, the latter hinged and removable. 7 Protective wooden cover. At back, insulating cover.

Part VII

DEVELOPMENT OF BEEKEEPING USING MORE ADVANCED HIVES

Chapters 38-40

38

Beekeeping Using Improved Traditional Fixed-Comb Hives

38.1 Why improvements were needed

Part V of this book (Chapters 20-32) dealt with keeping bees in fixed-comb hives by traditional methods which changed little over thousands of years. It was mostly done with the bees *Apis mellifera* and *A. cerana* which build parallel combs down from the top of a hive. Part VII now shows how beekeeping gradually advanced beyond that stage, largely by the improvement of hives.

From very early times beekeepers in some Mediterranean areas had cut out combs from the back of their horizontal hives. Beekeepers farther north had more difficulty in getting access to the comb attachments at the top of their upright hives, and they could not re-fix combs removed from a hive. Their beekeeping operations were mostly limited to harvesting honey, and catching and hiving swarms. Perhaps it was partly because of the limitations imposed by upright hives that most hive improvements were achieved in northern Europe; see Section 38.3

38.2 Horizontal hives

The earliest hives known were made of earth materials, and were used horizontally (Chapter 20). The opening from which honey combs were harvested was at one end of the hive (the back), and one or more small holes were made at the other end (the front) from which the bees flew out. The beekeeper could thus open the back end and smoke bees towards the front of the hive, away from the combs he wished to remove. It is noteworthy that most of the significant improvements to horizontal hives had probably been made by about 400 BC.

38.21 Hive extensions

The most widespread improvement to a horizontal hive was the use of an extension at the back of the hive during the honey flow to provide extra space for honey storage, as in Figures 38.2a, 38.2b and 38.2c. The extension was probably not added until the colony had already filled the hive itself, and when full it was removed with its combs of honey, after smoking the bees off them. Pottery hive extensions have been excavated from Ancient sites in Greece, Aegean islands and Crete (Table 23.2B), but are not known from Egypt or Spain in Ancient times or later, and

Figure 38.2a Extension for horizontal hives of wooden boards, Haltipasa near Manisa, western Turkey, 1985 (photo: E. Crane). The hive extension on the ground will be secured in place (with the two prongs horizontal) at the back of the protruding hive in the upper row.

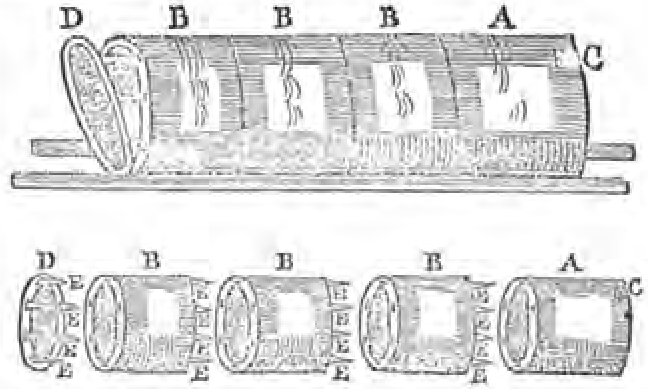
Figure 38.2b Pottery hive and extension, incurved to give telescopic fitting, Gharb, Morocco, 1963 (photo: E. Crane).

were not mentioned by Roman writers. With the horizontal Greek pottery hive (Figure 23.2a), the extension could be added only at the front of the hive.

In 1596 in Italy, Gallo published a drawing which shows a horizontal hive consisting of three wooden boxes joined together (Figure 25.2a). In recent times, extensions of pottery or other material were used traditionally to the east of the Mediterranean (Table 21.4A) – in present-day Lebanon, Turkey, Iraq, Iran and Arabia – and also in Morocco in North Africa and in Malta, but not with *Ferula* hives in Sicily. In Lebanon in 1970, where there were 32,000 traditional hives, one type was a standard fired-clay water pot about 50 cm tall, laid on its side, and the back of the hive was cut off so that honey combs could be harvested. If the honey flow was good another pot might be added as an extension. Extensions were used with hives for *Apis cerana* in the upper Indus basin, now in Pakistan and India (Section 29.5), where beekeeping was similar to that in the eastern Mediterranean region.

Horizontal hives were less common in northern

Figure 38.2c Bottle-shaped Maltese hives, 1969 (photo: K. Stevens). On the right a hive (R) stands upright on its open end. Behind it is a hive in position (flight entrance on the left) with two extensions added.



A A common Bee-hive.
B A prolonger to lengthen or eeke out the Hive withall.
C A hole cut in the upper end of the Hive A.
D A bottom or dore to shut up the Hive, whether it be single as A, or lengthened as A B B.
E The wooden pins in B and D for the joyning of them to the ends of A or B.

Figure 38.2d Horizontal straw hive, with three extensions (Hartlib, 1655).

Europe, and the first example known to have extensions was described by Hartlib (1655) from a letter written in 'High-Dutch' by John Moriaen (Raylor, 1992), 'communicating a Secret for the better ordering and preserving of Bees, practised beyond the Seas'. The Secret was the hive in Figure 38.2d, which incorporated 'prolongers', coiled-straw cylinders which 'lay upon two long poles or railes ... in a Garret, close under the Roof, where the Bees could creep in and out under the tiles'. To harvest honey, Moriaen unpinned the end D, used linen rags to smoke the bees towards the other end of the hive, 'and then I might freely take away the prolongers or additional hoops one after another, till I thought the Bees could not well spare any more Honey'. John Evelyn (c. 1655) recommended this hive and copied Hartlib's drawings of it in his *Elysium Britannicum* (D.A. Smith, 1965).

In Sweden, Nils Koch (1753) described a hive consisting of two rectangular straw 'boxes' on a wooden framework (Figure 38.2e), and Fleischer in Denmark (1777) showed one with four wooden boxes. The term 'storified' (Section 38.32) was occasionally applied to hives extended horizontally.

38.22 Treating a hive to influence comb attachments to it

An early way of improving pottery hives was to roughen the upper part of the interior where comb building would start, so that the bees could attach

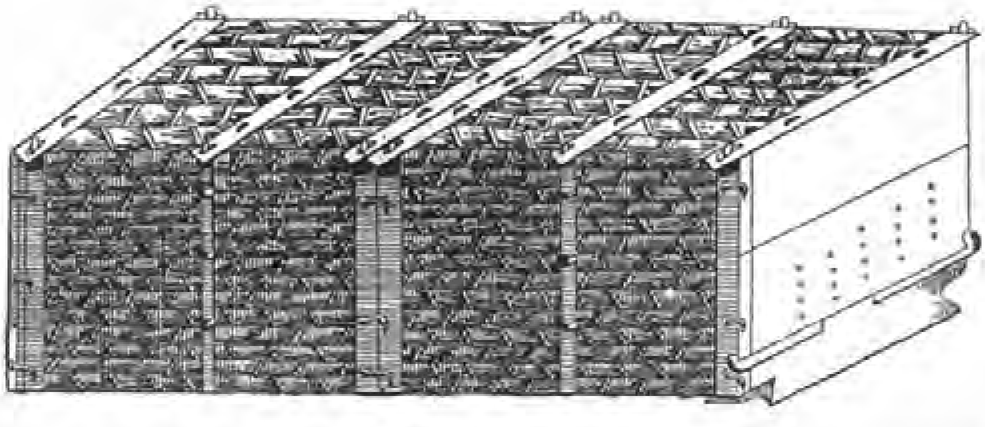


Figure 38.2e Rectangular Swedish straw hive on a wooden framework, with an identical box as an extension (Koch, 1753).

their combs more securely. This was done by making shallow incisions in the interior upper surface, and such incisions are known in hives of Ancient Greece from about 500 BC (Section 23.21); in hives of Ancient Spain from about 250-175 BC the incisions are more sparse but over all the interior (Section 21.7). They are indicated in Figure 23.2a (2, 3, 5, 6) and in Figure 21.7b. Before the hive was fired, the potter apparently ran a hair-comb or similar tool over the surface.

Quite separately from the above, some peoples who used horizontal hives were able to adapt them in a certain manner which controlled the *direction* in which the combs would be built. (Some others achieved the same end by beekeeping techniques, e.g. Section 21.43.) In tropical Africa, a Tugen beekeeper in the Rift Valley coated the interior with fluid from a goat's stomach, and when this started to dry he ran his fingers round the circumference of the interior surface; this left slight ridges which encouraged the bees to build combs across the hive (Nightingale, 1983). The fluid itself has an attraction for the bees (Beament, 1996). In the Central African Republic (end of Section 28.5), beekeepers fitted rings of wood inside the hive.

Beekeepers in certain other areas wanted to get combs built *along* the hive, because this seemed to produce stronger colonies. Some Kiongzi and Memire beekeepers in Tanzania achieved this by drawing parallel lines in charcoal, and then in beeswax, along the upper part of the interior, at the bees' comb spacing, 32 mm (Ntenga & Mugongo, 1991). In the Radfan Mountains in Yemen, inland from Aden, some beekeepers cut deep parallel grooves along the length of the upper surface of their wooden hive (Figure 21.4f).

38.3 Upright hives in the Old World

38.31 Hive extensions

In northern Europe, extensions were added below or above upright hives, and this increased the capabilities of a beekeeper in the following ways:

- getting more control over the bees;
- harvesting honey combs more easily without killing the bees, and with less interference from them;
- getting more honey from a hive;
- increasing the success of wintering colonies (see below).

These advances also stimulated much thought and discussion, which led later to the production of 'rational' hives (Chapter 40).

Swarm beekeeping with upright hives in north-west Europe – in which colonies were killed when their honey was taken – progressed by the addition of an extension during the honey flow; this was probably not done until after the Middle Ages. Although Malynes (1622) wrote of making 'skepes either of Straw or Wicker, and to be of two pieces', an extension was used with skeps of coiled straw rather than those of woven wicker; coiled-straw work could be made in a variety of shapes, and its firm edges enabled two parts to be fitted together securely and tightly.

Extensions added below coiled-straw skeps

Beekeepers using a skep closed at the top could add an extension only at the mouth. The earliest type of extension, used widely in Europe, was a shallow cylinder with the same diameter as the mouth of the skep, inserted underneath it (Figures 38.3a, 38.3f,B). It was called a ring or riser, or an imp or eke; the last

Figure 38.3a Eke or imp to place under a straw skep, made by Harry Wilson, Farndale, N. Yorkshire, England, 1954 (IBRA Collection B54/57).

Figure 38.3b Reconstruction of Isaac's 1803 Remunerator and Preserver hive (Alston, 1987).

two terms were derived from early northern European words for an addition or supplement. The beekeeper inserted cross-sticks at the top of the eke to support the combs which the bees would extend down into it.

Ekes must have been used in England by 1593 when Southerne's book said that they should be removed at the end of the year. Malynes (1622) described how to remove an eke when full of honey: 'Take a strong wyer, and cut your combes in two [between the skep and eke], and then have a parchment in readiness to follow the wyer, to keep asunder the wax from cleaving.' The skep was then stood on a board. Levett, writing about 1600 (published 1634), regarded ekes as impracticable because combs left in the skep when the eke was cut off would reach down to the floor-board. Lawson (1618) referred to 'an impe of three or foure wreathes [coils], wrought as the hive, the same compasse, to raise the hive withall'. Henry Best, a Yorkshire farmer, said in his 1641 accounts and records (published 1857) that 'there is in an underlay usually 5 wreathes'. A skep had 17 or 18, and a wreathe of straw was 2-2.5 cm thick. Best did not like ekes and recommended the beekeeper to 'buy the largest hive that you can get, because underlayes seldom do well'.

An elaboration devised by James Roberts in Devonshire, England, and described by Isaac in 1803, was to allow the colony to expand from the skep it was hived in (the Preserver), down through a communicating hole into a tall skep below in which it built new combs and stored honey (this skep was the Remunerator); see Figure 38.3b. Prior to harvesting (Deprivation), bees were got out of the Remunerator by blocking off communication between the two skeps and opening an entrance at the bottom of the Remunerator, through which bees left. They returned to their usual entrance in the Preserver, but could no longer enter the Remunerator – which gradually became emptied of bees.

Extensions added above coiled-straw skeps

In 1622 Malynes had told readers: 'cap your first swarmes' in July and old stocks in August. A cap was like a miniature skep, placed above a hole in the top of the skep containing the bees (Figures 38.3c, 38.3f,A). Its mouth diameter might be that of the skep or down to two-thirds of it. The skep itself was made with a flattish top and a central hole up to 7 or 8 cm in diameter to provide access to the cap. The coiled-straw work might be started round this hole, or round a circular wooden board in which a hole had been made. The cap was sometimes fastened to the skep with nails or staples, skewers or wooden pegs, as in Figure 38.3c. When full of sealed honey combs it was taken off; the bees were removed from it by smoke or other fumes (Chapter 34), or by driving (Section 27.12), and returned to their hive. The cap was sold complete with its sealed combs of honey, or combs were cut out and the honey strained from them.

By the late 1700s glass vessels shaped like a globe or a bell were available, and one or more of these

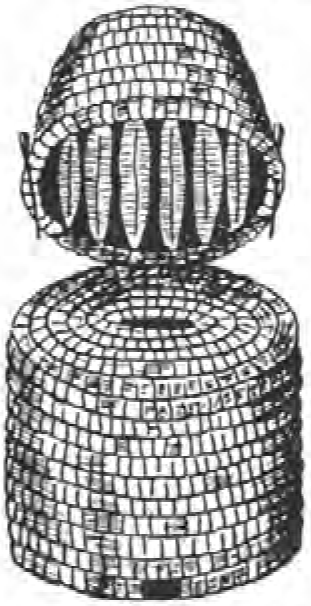


Figure 38.3c Flat-topped French skep, with a large cap (*calotte*), showing two fixing skewers (Hamet, 1874, redrawn in Marchenay, 1979)

Figure 38.3d Neighbour's Improved Cottage Hive, England (1878). The top of the straw hive is a wooden board with three holes to give the bees access to bell jars above, when the slides are opened. The skep has glass windows with hinged doors, and the straw cover is ventilated.

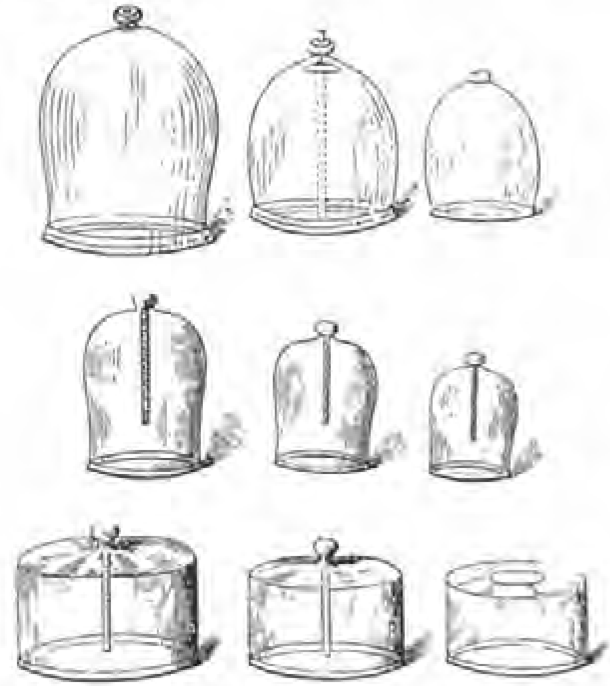


Figure 38.3e A variety of bell glasses (Times Bee Master, 1864). *First row* 'from Mr Pettitt's catalogue', prices are 4s. (10 inch), 2s. 6d (7 inch) and 1s. (4 inch). *Second row* 'Neighbour's are still better.' *Third row* 'I prefer Taylor's glasses to either.'

might be used instead of a cap, as in Figure 38.3d. Hoy (1788) explained how to deal with the glasses.

> When your Glasses are all filled with Honey, and sealed up, take them off; if they should be fastened, run a thin Knife under them, and take them away some distance from the Hive. ... Then sweep [the bees] off with a Feather as they come up the Glass, and they will fly Home to their Habitation. Tie your Glasses over with Paper, to prevent the Bees from robbing them of the Honey: they will keep good in Glasses two Years, if neither the Frost nor Damps get at them.

By the 1860s bell jars were available in great variety (Figure 38.3e).

If the access hole at the top of a skep was small, this discouraged the queen from moving up into the cap or glass and laying eggs there.

38.32 Storified or tiered hives

A more far-reaching development than the addition of an eke or cap was the 'storified hive' consisting of two or more modular units, tiered one on top of an-

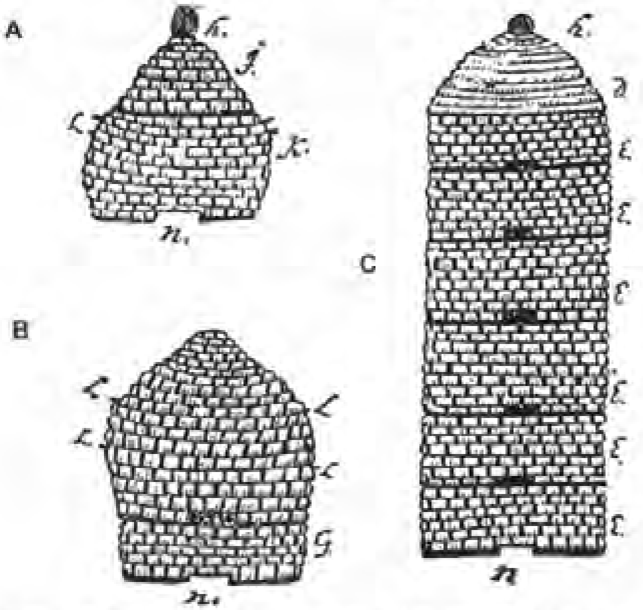


Figure 38.3f Swedish skeps drawn by the brother of Carl Linnaeus (S. Linnaeus, 1768). **A** Coiled-straw skep with cap, 'useful for late swarms'. **B** Skep with a 5-wreath eke. **C** Storified hive of 6 straw rings, each with 6-9 wreaths.

other. The unit might be a wooden box (Section 40.2), or a straw ring as in the Swedish hive in Figure 38.3f(C) - which is like an upright version of the hive in Figure 38.2d.

In an upright hive, bees attached their combs at the top and built them down to within a short distance of the floor, but left a small space there where they moved about. They did the same in each modular unit, which was separated off by a partial base such as a board with access holes, or a series of wide bars; see e.g. Figure 40.3b. The beekeeper could therefore remove a unit, with its combs attached at the top, to harvest honey or to make a new colony.

Straw rings (like ekes but deeper) were described by Hervigius in Denmark in 1649 (Sandklef, 1937), and later by others including the Count de Bourdonnaye in Brittany in 1757 (Société d'Agriculture ... de Bretagne, 1760) and Thomas Wildman (1768) in England: 'without any communication with the Count, the same thought occurred to us both.' The thought had also occurred to Samuel Linnaeus in Sweden, who described it in his 1768 beekeeping book from which Figure 38.3f is taken. Samuel looked after the family farm while his brother Carl – the great botanist – was living in Stockholm. In Germany Krunitz (1774), Berlepsch (1860) and Kanitz (1875) also described storified hives, and in England Isaac (1803) and Bevan (1827).

A beekeeper using a storified or tiered hive could harvest honey without killing the bees, and divide a colony in spring, so reducing his dependence on swarms. Hives of tiered wooden boxes, which had been designed from the 1640s onwards, were more versatile than straw rings and led to more substantial advances (Chapter 40).

38.33 Some other improvements

On the Greek island of Kythera, a rectangular hive was made in recent times by hollowing out a block of soft stone (tuff), and placing top-bars across the top (Nicolaidis, 1955). Movable-comb hives in general for *Apis mellifera* are discussed in Sections 39.2 and 39.3.

The island of Brač (off the Dalmatian coast near Split) lacked trees, and in 1776 Abbot Alberto Fortis described rectangular hives made of slabs of stone. Ritterman (1953) quoted his description and published photographs of the hives, and Goetze (1931, 1953) said that 'twigs of olive or mulberry wood are pushed in between the side plates and the roof to serve as starters for the combs; the native beekeepers thought this necessary because otherwise the combs would not stand the high summer temperature of the stones forming the roof'. It seems unlikely that the twigs were the type of spaced top-bar described in Section 39.12, but they enabled honey combs to be harvested from the top of these hives which were embedded in the ground.

In the late 1800s some skep beekeepers in Britain placed a box of sections on top of a skep, instead of a cap (Figure 38.3g); see Section 43.1.

Queen excluders were used before movable-frame hives. Their origin is not known, but Prokopovich made large rectangular ones of wood in 1814, by cutting parallel slots of the correct width in a board (Section 43.3). In 1803 an Irish book by Doubourdieu included a drawing of a skep with a 'grate for the bees to pass through' to reach a glass bell jar placed above it. The grating looks similar to a queen excluder, but the text does not suggest that its purpose was to exclude the queen from the combs in the bell jar. Figure 38.3h shows a queen excluder for placing over the hole in the top of a skep, to prevent the queen entering and laying eggs in the cap.

A queen cage for introducing a queen safely to a colony in a skep was also used in traditional beekeeping; for a few days the queen was left in the cage where she was fed by workers (through holes in it), and she could then safely be set free. Dutch skep beekeepers used many different types; see Jacobs and Plettenburg (1978). Figure 38.3i shows a cage mounted on a stick which has a spike at the other

Figure 38.3g Straw skep with a box of sections above (British Bee-Keepers' Association, 1884).

Figure 38.3h Queen excluder used for an English skep (IBRA Collection B54/91). The diameter of the grid is 6 cm. A gap of 4.2-4.5 mm between wires allowed workers, but not a queen, to pass between them.

Figure 38.3i Dutch queen cage (length 3 cm) for use in a skep (IBRA Collection B68/70).

end for pushing into the straw of the skep. In 1772 Gélieu in Switzerland described a queen cage inserted in the centre of a hive (Section 44.24).

Transparent inspection windows, which allowed the beekeeper to check on the bees inside, are discussed in Section 37.2.

38.4 Upright hives in North America

From the 1620s onwards, honey bees (*Apis mellifera*) were taken in upright hives (skeps?) from northern Europe to mainland North America, where many cavities in tree trunks were available for swarms to occupy. Beekeepers cut off logs containing nests of bees to use as hives (Chapter 31), and upright hives were also made of wooden planks, and some skeps of straw. Extensions were sometimes added above an access hole at the top of box hives: a 'honey box' or one or more honey 'drawers', which were removed when full of honey. In his *History of American beekeeping* (1938), Pellett devoted only a few pages to these hives: 'At the time of Langstroth's invention the only step forward in America had been to place a cap over the box in which the bees were kept, to permit storing honey above the brood chamber.'

In the early centuries of European settlement, there seems to have been little knowledge of advances in European beekeeping, or interaction with them. Also, North America had little infrastructure of learned societies, journals and libraries during its first two hundred years of beekeeping with honey bees. The American Philosophical Society was founded in 1743 in Philadelphia. Mechanical improvements in printing in the USA after 1820 made mass book production possible, and some thirty beekeeping books had been published before Langstroth made his movable-frame hive. Many of them promoted their author's patented hives, and the emphasis was more on the fight against wax moths (see below) than on colony management. Bee forage in North America was much richer than in Europe, and beekeepers could in general get honey more easily so it was less essential for them to devise ways of increasing the effectiveness of colonies in storing honey.

In the early 1800s the greater wax moth (*Galleria mellonella*)* was inadvertently introduced from Europe, and it subsequently destroyed many colonies. According to a letter from Dr J.P. Kirtland of Cleveland, Ohio (Langstroth, 1859), the moth was

*The female moth lays eggs in the combs, and the larvae eat passageways through cell walls and so damage them. Colonies of bees too small or weak to protect all their combs from wax moths are especially susceptible, and can die as a result of infestation.

not present in the USA until after 1805. Its appearance was reported by the *Boston Patriot* in 1806, and within two years it had infested so many hives around Boston that 80% of the apiaries were abandoned (Pellett, 1938). Affleck (1841) dated its entry earlier: in the Boston area about 1800, Connecticut 1805, Philadelphia 1812, Ohio 1827. The large number of honey bee nests in trees contributed to the moth's rapid spread, and in 1831 J.V.C. Smith referred to its ravages throughout the (then) USA.

These losses stimulated experiments in designing hives which might reduce wax moth damage. Many such hives had a sloping floor board or other device for removing detritus containing eggs of the wax moth from the bottom of the hive. Nearly 600 patents for 'new' hives were listed in the *US Patent Office Index* (Leggett, 1874) from 1810 onwards, 74 of them before Langstroth's patent in 1852 (Section 40.7).

Moses Quinby, who started beekeeping in 1828, a year after Langstroth, learned from his own observations rather than from books. In 1851 he started to write a book, *Mysteries of bee-keeping explained*, which was published in 1853. Pellett (1938) suggested that it was a source of satisfaction to both Quinby and Langstroth that their books were published in the same year, so that there was never any suspicion that one borrowed from the other. Among the 'improved' box hives Quinby mentioned were the following, of which the last three were patented.

- Chamber hive with two apartments: brood box below and 'chamber' containing glass boxes for honey sections above.
- Box hive constructed by Mrs Griffin in New Jersey and described in *The American Farmer* in 1829, with a frame which was some sort of carrying device.
- Weeks's improvement 'sufficient to be sanctioned by a patent', in which the bottom was about 8 cm narrower than the top 'to prevent the combs from slipping down'.
- Suspended hives, examined by 'unhooking the bottom board, and getting down on your back ... to look up among the combs, and there see nothing satisfactory for want of light; or to lift the hive from its supporters, and turn it over'.
- Hall's patent (1839), with two sloping boards as the bottom 'to discharge the worms [wax moth larvae], etc.'
- Jones's patent hive (1842) for multiplying and equalizing (see also Jones, 1843b); also Jones's patent dividing hive (1845) in which bees in the half without a queen reared one.

Wyatt Mangum located examples of some of the early hives (Bambara, 1988); in 1991 and 1992 he described Parish's hive from 1834, and those of Francis and Carlisle from 1842, Fulkerson from 1844, Dalton and Stevens from 1850, and Phelps from 1852. In 1953 I saw an early box hive in Springfield, MA, in the apiary of the third generation of MacCarters who had kept bees (Figure 38.4a). The brood box was open at the bottom, and had two holes in the top about 2 cm across leading to a honey box (drawer) above, which was also open at the bottom.

Figure 38.4a New England box hive with separate honey 'drawer' at the top, 1953 (photo: E. Crane).

39

Traditional Movable-Comb Hives with Top-Bars

39.1 Introduction

39.11 Principles of fixed-comb and movable-comb hives

The cavity-nesting honey bees *Apis mellifera* and *A. cerana* build a number of parallel combs, as in Figure 3.1a. Hives discussed in previous Chapters were receptacles made by beekeepers which simulated natural nest cavities: bees fixed their combs to the upper surface of the hive and built them downwards from it. The beekeeper was unable to remove a comb without breaking or cutting its wax attachments to the hive.

This Chapter deals with movable-comb hives, from which the beekeeper could remove any individual comb without cutting or breaking the wax. The hive had an open top, across which parallel horizontal top-bars were laid, and the bees attached each comb to one of these bars instead of the hive itself (Figure 39.1a). It was usual to provide each bar with a ridge or some other protrusion underneath – for instance of wax – along its centre line; this encouraged the bees to start building the comb down from this, and the comb could then be lifted out by its top-bar, as in Figure 39.3a, *right*. It was essential that the bar spacing exactly matched the natural spacing of combs built by the bees. In the 1990s several beekeepers in Greece told me that the space (width) allowed for each top-bar was the width of a man's two fingers or, alternatively, the distance between the two joints of the thumb; both distances are around 40 mm.

Figure 39.1a Sir George Wheler's drawing of a Greek top-bar hive (1682). Wheler drew narrow top-bars, but described them as 'broad, flat Sticks' which had to be separated 'from one another with a Knife'. Also he drew a coiled-straw hive, but said it was made of willows or osiers.

Most top-bar hives for *A. mellifera* in Europe were made with sides sloping inwards from top to bottom, and the bees made few if any attachments of combs to the sides; the heavier honey combs were more likely to be attached than brood combs. *A. cerana* in south-east Asia builds smaller and lighter combs which need less support, and the hive sides were often vertical (Section 39.4). Karlsson (1990) found that *A. cerana* did not attach comb containing brood to vertical side walls. One comb 35 cm long and only 10 cm wide was attached along the top 3 or 4 cm of its length, where honey was stored.

Dzierzon's 1848 rectangular hive with vertical sides, fitted with top-bars and worked from the back, is discussed under his name in Section 40.6. New types of top-bar hives designed during the late 1900s for use in developing countries are described in Section 40.8.

39.12 The archetypical movable-comb top-bar hive: Greece 1678

Systematic travel to Greece for the discovery of buildings and works of art was begun in 1675/76 by Dr Jacob Spon from France, and George Wheler from England who was knighted by King Charles II in 1682 (Bone, 1966). At Hagio Kyriani monastery* in Attica, they saw hives in use which Spon described as follows in his 1678 book on the travels.

> Leurs ruches sont couvertes de cinq ou six petites planches, où les abeilles commencent d'attacher leurs rayons, avec un petit toit de

*In Karsariani, on the Athens side of the north end of Mount Hymettus.

paille par dessus. Ainsi, quand ils veulent partager leurs ruches, ils n'ont qu'à tirer la moitié des planches qui tiennent les rayons attachez, & les mettre dans une autre ruche. Pour les moins effaroucher, ils attendent qu'il y en ait une partie en campagne, & alors ils mettent une ruche neuve au même endroit de la vieille bâtie de la même façon; de sorte qu'elles y viennent le soir, croyant que c'est leur ancien logis, & ne trouvent rien dedans, elles commencent à bâtir leurs cellules.

Spon added Wheler's name to his own in the title of his book. Wheler was gratified, but he found some information lacking in Spon's text, and published his own book in 1682. Wheler said (p. 411) that 'here [at Hagio Kyriani] they never destroy or impair the Stock of Bees in taking away their Honey. A thing I no sooner knew, but I was inquisitive to understand their Method in Ordering the Bees'. He explained quite fully how a beekeeper using these hives could: (a) remove any comb from the hive, (b) check that adequate winter stores were left for the bees, (c) harvest combs of honey without brood or adult bees, (d) inspect and manipulate colonies while foraging bees were out of the hive, (e) carry out swarm control, and (f) divide a colony into two. Wheler published the following description with the drawing in Figure 39.1a.

The Hives they keep their Bees in, are made of Willows, or Osiers, fashioned like our common Dust-Baskets, wide at the Top, and narrow at the Bottom, and plaister'd with Clay, or Loam, within and without. They are set the wide end upwards, as you see here. The Tops being covered with broad flat Sticks, (as at C.C.C.) are also plaistered with Clay at the Top; and to secure them from the Weather, they cover them with a Tuft of Straw, as we do. Along each of those Sticks, the Bees fasten their Combs; so that a Combe may be taken out whole, without the least bruising, and with the greatest ease imaginable.* To increase them in Spring-time, that is, in *March* or *April*, until the beginning of *May*, they divide them; first separating the Sticks, on which the Combs and Bees are fastened, from one another with a Knife: so taking out the first Combs and Bees together, on each side, they put them into another Basket, in the same Order as they were taken out, until they have equally divided them. After this, when they are both again accommodated with Sticks and Plaister, they set the new Basket in the Place of the old one, and the old one in some new Place. And all this they do in the middle of the day, at such a time as the greatest part of the Bees are abroad; who, at their coming home, without much difficulty, by this means divide themselves equally. This Device hinders them from swarming, and flying away. In *August* they take out their Honey; which they do in the day-time also, while they are abroad, the Bees being thereby, they say, disturbed least. At which time they take out the Combs laden with Honey, as before; that is, beginning at each out-side, and so taking away, until they have left only such a quantity of Combs in the middle, as they judge will be sufficient to maintain the Bees in Winter; sweeping those Bees, that are on the Combs they take out, into the basket again, and again covering it with new Sticks and Plaister.

We do not know how this relatively advanced hive originated, but Section 39.5 suggests one possibility. Nor do we know when it was first used, but it is likely that the wicker hive described above was a later type than the heavier and breakable pottery *vraski* (see below).

39.2 Pottery top-bar hives for *Apis mellifera*

The first part of Table 39.2A gives recorded dimensions of traditional top-bar hives from the 1600s to the 1900s.

The *vraski* (Figure 39.2a) is known to have been used in the central and west parts of Crete except the Kolimbari and Akrotiri peninsulas. Zymbragoudakis (1979) gave the height of existing examples, fitted with up to ten top-bars, as 36 cm and the mouth diameter as 35 to 41 cm. Most surviving hives have sloping sides, but some have upright sides except for the lower third which slope inwards. Before firing a hive, a horizontal flight entrance about 8 x 0.6 cm was made near the integral base, and two handles were added for lifting. In use, a layer of small leafy branches tied together at the centre – like a hackle – was placed above the top-bars to protect the hive from rain, heat and cold; it was kept in place by a heavy roof like an inverted shallow dish, shown in Figure 39.2a (*left*).

Nicolaidis (1955) mentioned a similar pottery hive

*The Greek beekeepers must have placed the bars at the natural spacing of combs built by their bees, but Wheler did not state this and probably did not understand that the spacing was critical; many of his readers would not understand it either.

Table 39.2A

Representative dimensions (cm) of traditional movable-comb and horizontal fixed-comb hives in and near Greece

Type	*Where*	*Material*	*Period*	*Mouth diameter*	*Height/length*
Upright movable-comb hive with top-bars, worked from (wide) top					
					Height
vraski	Crete	fired clay	late 1900s	35-41	36 (up to 41)
anastomo kofini	mainland Greece	wicker	Wheler, 1682	32*	32?*
	Crete	wicker	Rocca, 1790	42-44	48
	mainland Greece	wicker	late 1900s	41	43
distomo kofini	Crete, mainland Greece	wicker	late 1900s	41	39
Horizontal fixed-comb hive without top-bars, worked from wider end only†					
					Length
constructed with only one end open:					
	Aegean islands, mainland Greece	fired clay	–400 to –200	37	43
	Aegean islands, mainland Greece	fired clay	–100 to –1	37	50
	Aegean islands, mainland Greece	fired clay	+550 to +600	30	60
	Aegean islands	fired clay	late 1900s	37	84
solin	Crete	fired clay	late 1900s	32	68

* Estimated from Figure 39.1a, assuming 9 bars at a natural comb spacing of 36 mm.

† From Table 23.2A, except final entry which is from Section 22.23.

in Crete, of about the same size but open at both top and bottom and placed on a flat stone, like the *distomo kofini* (Section 39.3). Section 38.33 mentions hives made of stone.

Figure 39.2a Pottery top-bar hives (*vraskia*) from Crete. *left* With pottery cover in place (photo: E. Crane). Height 37 cm, diameter 36 cm (mouth), 26 cm (base), internal. *right* Without cover, showing insulating layer of leaves above (photographer unknown).

Pottery vessels and representations of them, wrongly interpreted as hives

So far no movable-comb top-bar hives (*vraskia*) are known to have been excavated from Greece or its islands, although many examples of horizontal fixed-comb hives have been found. Several vessels have been incorrectly identified as *vraskia*. The most widely described (Figure 39.2b), dated to about 340-

Figure 39.2b The Orestada vessel at Isthmia (photo: P. Papadopoulo). Height 29 cm, diameter 34 cm (mouth), 22 cm (base), internal.

Figure 39.2c Two-handled jar on reverse of coin from Cypsela (Roux, 1963).

260 BC, was found in 1955-56 during excavations of an ancient dye works at Isthmia near Corinth. It has been referred to as the Orestada vessel because of the ownership inscription ORESTADA. The sides were flared outwards at the top, and there were shallow incisions over most of the interior. It is known that honey was used as a preservative for dye in the Ancient World, and Kardara's report on the vessel (1961) said: 'Mr D.I. Pallas has identified this vessel as a beehive for the following reason. In the Justinian Fortress at Isthmia, he had found previously several vessels having: (1) a name scratched outside, and (2) groups of vertical grooves inside (Broneer, 1958), and these had been identified as hives.' The small opening near the base of the Orestada vessel, assumed to be a flight entrance, seemed to settle the identification as a hive. However, this vessel would have been very small for a hive (17 litres or less), and the outward curve of its sides is atypical. Moreover Kardara and Papadopoulo (1984) established that the part containing the 'flight entrance' was entirely reconstructed by the restorer, who believed the vessel to be a hive and therefore made such an entrance for it. It has been suggested that this vessel, and two smaller ones found, were water or sand clocks.

A large jar found in pieces at Akrotiri on Thera, dated to *c.* 1600-1500 BC, was wrongly identified as a hive by Doumas (1976); it was a lidded strainer with a perforated base some distance above the bottom.

Figure 39.2c shows the design of a two-handled pottery jar on the reverse of a coin from Cypsela (a Greek city in Thrace), which Roux (1963) described as a hive. The word *kypsela* means hive in modern Greek, but a storage jar or bin in classical Greek (Barrett, 1974), and this design must have been a pun on the city's name. Designs on Greek coins from Thracian Chersonese (modern Gallipoli peninsula), and from Dyrrhachium on the Adriatic coast, incorporate objects that look rather like upright straw skeps, but are not (Crane & Graham, 1985); see also *Note* on p. 404.

Among the pottery illustrated by Siebert (1988) from the House of Comedians on Delos in the Aegean, one item was described as 'an unpublished hive of the Vari type'. It is not like the hive from Vari, but its shape is appropriate for a top-bar hive; dimensions were not available.

39.3 Woven top-bar hives for *Apis mellifera*

The wicker hive in Attica described by Wheler in 1682 (Section 39.12) was known as *anastomo kofini*, open at the top only. Figure 39.3a shows combs lifted out of such hives. It was much used in the south-east of mainland Greece, and Figure 39.3b shows part of an apiary of the hives in Attica. When harvesting honey, beekeepers routinely removed half the combs in a hive, on the right and left sides in alternate years, and combs were thus regularly renewed. They left a narrow strip of comb attached to each top-bar, so that the bees would rebuild the comb along the same line. In 1790 della Rocca referred to 'more than one person' who described to him its use in Crete, but said it was not then used elsewhere in the Levant (Vol. II, pp. 465-466).

According to Georgandas (1957), the hive was made of either split reeds or twigs from the chaste tree (*Vitex agnus castus*), and the top-bars were of hardwood: juniper, *Arbutus*, wild olive or holly. The flight entrance was a 3-cm hole some distance above the bottom. Walls were well plastered inside and out, with a mixture of clay and ash from wood or charcoal, and the hive was protected with a cover of rye straw or the wild grass *Bromus tectorum*.

Another top-bar hive was used in the less dry north-west of Crete, especially the Khania region and

Figure 39.3a Greek top-bar wicker hive (*anastomo kofini*). *left* Example in the IBRA Collection (B58/1). Height 53 cm, diameter 43 cm (mouth), 28 cm (base). One of the combs removed from it stands against the hive, upside down on its top-bar. *right* Comb with bees and brood, removed from a top-bar hive, 1965 (photo: P. Papadopoulo). The gap left by the top-bar can be seen just below it.

the Kolimbari and Akrotiri peninsulas, and also in the peninsula in eastern Laconia that lies opposite them on the Greek mainland. It was an upright woven cylinder with both ends open, known as *distomo kofini* or *amphistomo kofini*. The weaving was covered on the inside with a layer of clay mixed with chopped straw, and the cover and base were sealed on to the hive with mud. Top-bars were cut from

Figure 39.3b Part of an apiary of top-bar wicker hives protected by hackles, Phyli, Attica, 1957 (photo: D. Georgandas).

Figure 39.3c Migratory apiary of about 100 top-bar wicker hives (*distomo kofini*) on stones, Kambani (Akrotiri), Crete, 1939 (photo: P. Papadopoulo). Each hive stands on a stone slab, to which the wicker is plastered.

brushwood with an adze, three from a branch, and the 120° angle was positioned underneath to make a ridge. In winter the hive was placed on a slightly sloping flat surface (so that water could run off) to which the bottom of the hive was sealed except for a flight entrance.

Georgandas (1957) said that this hive was 'especially designed for migratory beekeeping', providing better ventilation during transport than one with a closed base. Each hive to be moved was tied inside a jute sack provided with ventilation holes. If the migratory apiary was inaccessible to a pack animal, the beekeeper himself carried the hives, two on his back and one on a shoulder. Figure 39.3c shows a large migratory apiary of the hives in Crete.

39.4 Wooden top-bar hives for *Apis cerana*

Figure 39.4a shows a traditional movable-comb top-bar log hive for *Apis cerana* used by certain mountain peoples in north Vietnam, previously known as Tonkin (Toumanoff & Nanta, 1933). The hive was 60-100 cm high and 20-50 cm in diameter; at the top, grooves were made in the wood (*des échancrures sont disposées*) to accommodate the ends of parallel top-bars (*baguettes*) of bamboo or wood, from which the bees built their combs. The hive was covered at the top with a round piece of wood coated with mud or buffalo dung. (The same peoples also used a variety of fixed-comb hives: wooden boxes, logs and woven cylinders.) Toumanoff (1933) described the use of similar top-bar hives by Annamese peoples in

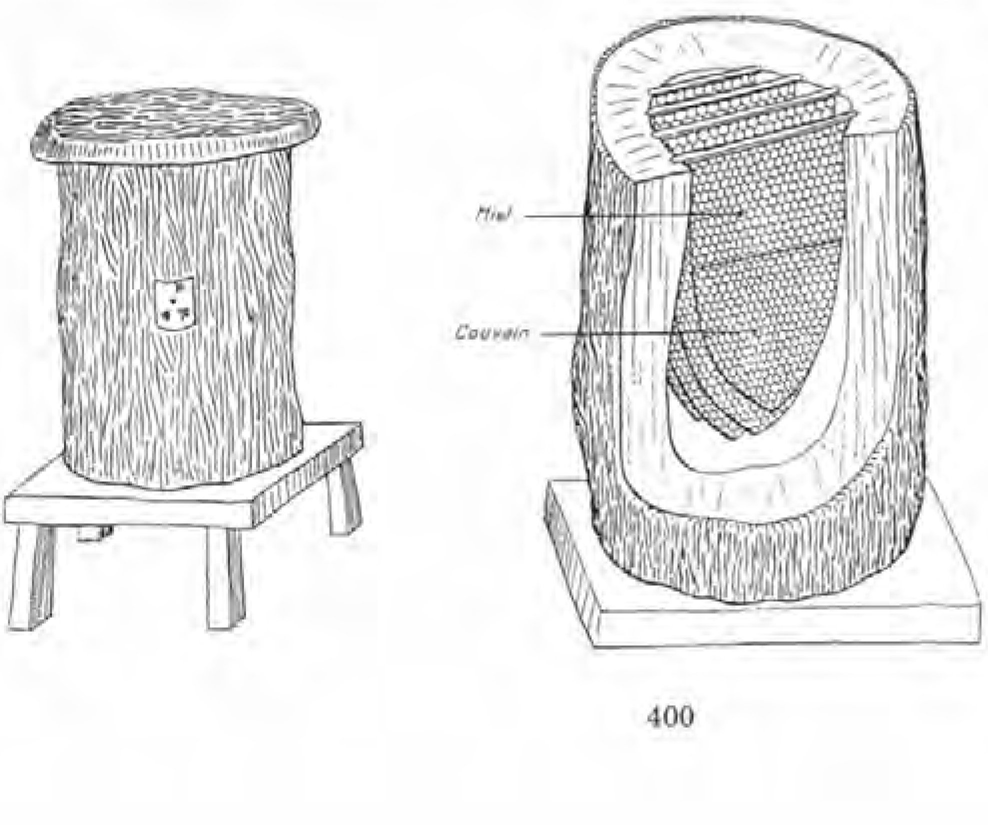


Figure 39.4a External and internal views of a top-bar log hive, Tonkin, north Vietnam (Toumanoff & Nanta, 1933).

Figure 39.4b Top-bar log hive used by a beekeeper of the Nung hill tribe, Dai Tù, Bac Thai province, north Vietnam, 1989 (photo: E. Crane). The photograph shows one comb lifted out, and the grooves that support the ends of the top-bars.

Tonkin, and published six photographs in which top-bars (*baguettes*) – usually five – were supported in a similar way.

In north Vietnam near the border with China, I saw top-bar hives in 1989, similar to those described in 1933, with the top-bars resting in individual grooves (Figure 39.4b; see Crane *et al.*, 1993b). These hives were then used by hill peoples in at least four areas north of Hanoi, between 22° and 23°N, and they may also be used in other areas in the region:

Bac Son, Ha Noi district (30 km N)
Dai Tù, Bac Thai province (90 km NNW), Nung people
Lao Cai province (260 km NW), Mung and other peoples
Chièm Hoa, Ha Tuyen province (150 km NNW).

I saw similar hives on Cat Ba island off the coast east of Hai Phong, where they were probably introduced more recently.

In Bac Thai and probably elsewhere, only the upper part of the comb (containing honey) was harvested. The beekeeper removed a comb and shook the bees off it, then placed it on a flat surface and cut off the upper part containing sealed honey. He re-attached the top-bar to the lower part of the comb which contained brood, by threading two lengths of straw through the brood comb and tying them over the top-bar. In Bac Thai, the beekeeper sometimes made preparations in advance, mainly with hives where combs were long (more than 50 cm) and narrow (internal hive diameter less than 25 cm). Before each top-bar was put into a hive, he passed the two ends of a string of straw or jute through a hole near each end of the top-bar, and tied a knot so that the string hung in a curve extending 40 cm down. When the comb was subsequently built, the curved string was incorporated in it. After the honey comb at the top had been cut out, the brood comb below (*couvain* in Figure 39.4a) was pulled up to the top-bar by the two ends of the string, and two new knots tied to secure it in place. The comb in Figure 39.4c is at this stage.

It seemed quite common for beekeepers to position the top-bars a few centimetres below the top of the hive on which the cover rested; the bees then also built combs upwards from the top-bars and stored a little honey in them, which could be harvested without cutting combs below the top-bars. It may be that *Apis cerana* is more inclined than *A. mellifera* to build honey comb upwards: in Korea beekeepers say it builds honey comb upwards through one or even two empty shallow boxes placed above comb top-bars.

In Bac Thai and Ha Tuyen, some of the log hives were hollowed out to give a rectangular cross-section,

Figure 39.4c Honey harvesting from top-bar hives, north Vietnam (Toumanoff, 1933). The lower (brood) part of a comb removed from the hive; it has been tied to its top-bar before being returned to the hive.

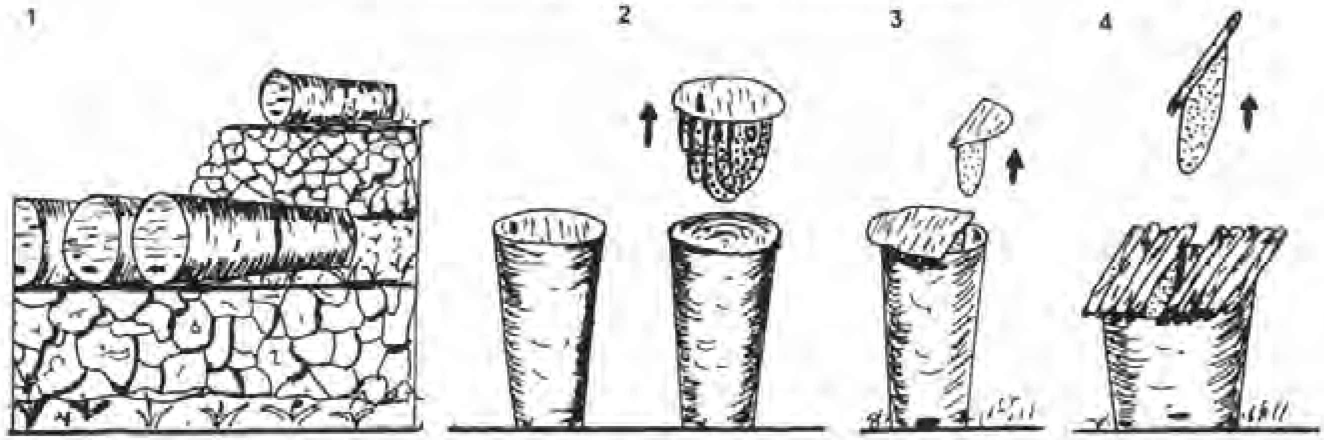


Figure 39.5a Four possible stages in the development of a top-bar hive from a *solin* or similar long horizontal hive, of present-day dimensions (Ifantidis, 1983).
1. Present-day *solines* on terrace walls, as in Crete and Ios.
2. Present-day *solin* or similar hive: *(left)* stood upright, with cover in place; *(right)* flat cover lifted off after swarm has built comb in hive.
3. As 2, but cover in more than one section.
4. As 3, but cover consisting of individual bars at the correct comb spacing.

so that top-bars were all of the same length. Top-bars of equal length were also used in box hives in Ha Noi district and Cat Ba – and in Ha Noi province, although there the boards had to be purchased, because deforestation had led to a shortage of timber.

The earliest description I know of top-bar hives for *A. cerana* is by C. Rialan who was Vice-President of Nguyen province, now Bac Thai, in 1887. He also described tethering the queen, and attaching her to a central top-bar when hiving a swarm. He said that the 'natives' did not divide colonies in top-bar hives even when they found queen cells, and he was puzzled by this.

According to Faraut (1907), such top-bar box hives were in use in Hanoi in the early 1900s, and one beekeeper had 42 of them. Faraut described a square wooden box, 35 cm across and 45-50 cm high, with a volume of 55-60 litres. The top, and the side containing 3-9 small flight entrances, were removable. On the inner face of the two opposite fixed sides, 5 cm below the top, a horizontal wooden strip was fixed to support the ends of movable top-bars that carried the combs (*lamelles mobiles porte-rayons*); these were made of split bamboo 25-50 mm wide. Top-bars were primed with pieces of old brood and honey comb, and the bees built their combs down from these. Beekeepers increased the number of colonies by dividing strong ones or making artificial swarms, and they knew how to control swarming by judicious removal of sealed queens cells. They also removed sealed drone brood.

39.5 The origination of movable-comb top-bar hives

39.51 Hives for *Apis mellifera* in Greece and Crete

Ifantidis (1983) suggested that these hives might have arisen in the following way, illustrated in Figure 39.5a. A tall pottery storage jar, or a flared horizontal pottery hive (1) as used in Crete (*solin*, Section 22.23), happened to be placed upright with the mouth at the top and covered with a poorly fitting board (2); a swarm occupied it and built combs down from the board. Provided the sides sloped in towards the bottom, the bees would probably not attach combs to them, and if the wooden board was lifted up, all the combs would come up too, as in (2); see also Figure 39.5b. Ifantidis called this a 'movable-nest hive'. Beekeepers might subsequently have divided the board into two – or used two or three narrower boards (3) – and finally used a separate strip for each comb (4), 'with adjustment of the dimensions of the conical cylinder'.

Table 39.2A gives dimensions of top-bar hives in recent centuries and, for comparison, of excavated horizontal fixed-comb hives in Crete, Greece and Aegean islands. The length of horizontal pottery hives known from before about 200 BC (43 cm) is similar to the height of recent upright pottery top-bar hives measured in Greece and Crete (36-41 cm). If one of the earliest known horizontal hives (P11017, third entry in Table 23.2A) had been stood on its closed end and given a flight entrance, it would have looked like one of the top-bar hives – without any

Figure 39.5b One-piece rectangular cover used on a *vraski*, removed with all combs attached (Ifantidis, 1983). The cover board has been supported by four forked sticks, so that honey combs can be harvested. This picture corresponds to Figure 39.5a (2, right, top).

'adjustment of dimensions', and would conform to Zymbragoudakis's description of such hives in Crete (Section 39.2). However, shallow incisions on the upper part of the inner surface of this hive (P11017) suggest that it was used on its side.

These hives must have originated some time before 1675, but at present we do not know when. Graham (1975) discussed whether or not they were used in Ancient Greece, and concluded that 'the statements in Ancient literature on beekeeping can be accounted for on the assumption that only primitive hives were used'.

Horizontal cylindrical hives were widely used in the Mediterranean region, and a few were flared – for instance in Syria and Iran (Table 21.4A). But, except in Crete, Aegean islands and mainland Greece, no record has been found of their traditional use upright with top-bars, and no passage in Roman writings suggests any knowledge of them. Similar horizontal pottery hives were also used in Indian Kashmir (Figure 29.5b), but I have found nothing to indicate that these were ever stood upright and used with top-bars.

39.52 Hives for *Apis cerana* in north Vietnam

A. cerana combs are not usually attached to vertical hive sides, so upright logs could be used as top-bar hives, and these were traditional hives in some mountainous parts of north Vietnam.

Present traditional hive use (*c.* 1990) differs in several ways from that with *A. mellifera* in Europe. The same beekeeper is likely to use a variety of hives, and to adapt his use of any one hive to the shape and size of an individual log he acquires. He shows more ingenuity and adaptability, and less conformity to a single system. When questioned, a beekeeper would say that he learned to use top-bar hives from his father or grandfather, and he probably had no access to written texts or instruction on beekeeping. Toumanoff and Nanta (1933) believed that the beekeeping was 'old' because the beekeepers knew about the bees' life history and behaviour, and because they used a well developed colony management. These authors regarded the care given to the colonies as 'comparable to that of good beekeepers in Europe'. The top-bar hives could have been originated when a beekeeper placed a loose flat cover over the open top of a log hive stood upright – as in Ifantidis's 'movable-nest hive' in Greece. We have no idea of the time-scale.

Records made in 1989-92 described the use of log hives with top-bars by beekeepers living in Vietnam north of Hanoi and near the Chinese border, but over 200 km apart. Several Chinese beekeeping books show bees being driven into a basket held above an upright barrel hive with top-bars, but the text gives no information about this hive. According to Huang Wen-Cheng (1993), similar top-bar hives had been used in some southern and south-western provinces of China: Jiangxi (Guangxi) adjoining Yunnan which

borders on Vietnam, also Hunan, Sichuan and Hubei. The hive, which was said to be 'very ancient', was still used in remoter areas by some farmers, but does not seem to have been regarded as having any special significance or benefit. I know of no traditional movable-comb top-bar hives in any other Asian country, but they should be sought.

Beekeeping with top-bar log hives by hill tribes in north Vietnam has been recorded only since 1887, but the fact that it can still be found in several well separated places in sparsely populated mountainous country suggests that it may be quite old. Section 29.41 refers to other beekeeping practices in Vietnam, recorded in AD 200s and 700s, and it seems just possible that the removable 'lid' of the hive described in the 700s was (or was fitted with) top-bars.

39.53 Why did the hives originate in these regions?

It seems reasonable to ask why movable-comb top-bar hives were not originated elsewhere in Europe or Asia – or indeed Africa. Accepting the argument above based on Ifantidis's supposition, the starting point was an empty horizontal hive (with flared sides for *A. mellifera*), stood upright on its smaller closed end with its open top loosely covered. Such hives were used in Greece and Crete, but perhaps not elsewhere, although the great variety of hives east of the Mediterranean might have included some. In Africa, cylindrical horizontal hives were very common, but not with flared sides. In Asia, beekeepers in many areas made hives from upright logs and barrels, and not all local variants have yet been studied.

The final advance in hive design was to extend the movable top-bar by adding two end-bars and a bottom bar to make an easily removable frame (Section 40.7). This advance was achieved as a result of developments in upright hives for European *A. mellifera*, in both northern Europe and North America (Chapter 40). It was apparently not achieved independently in Asia, and movable-frame hives were introduced there from Europe and North America (Section 41.62).

Section 40.8 discusses the use of purpose-made wooden boxes as rational top-bar hives from the 1970s, in development programmes.

Note added in proof

V.R. Anderson-Stojanović and J.E. Jones have done further work (1999, not yet published) on the Orestada vessel (p. 398) and on two other vessels (IP 2512 and IP 2215) from the Sanctuary of Poseidon at Isthmia near Corinth (see Crane, 1983, p. 202). The results suggest that these might possibly be examples of the 'movable-nest hive' suggested by Ifantidis (1983) as an intermediate stage between horizontal hives and the upright movable-comb hive (Section 39.5, Figure 39.5a).

40

Rational Improvements in Hives, 1649-1851

40.1 Introduction

This is the first Chapter devoted to rational hives: hives whose design was governed by thought and reason rather than by inherited tradition and extemporary improvements.* Almost all the developments described here were made with hives for the European honey bee *Apis mellifera*.

The seeds of rational beekeeping were sown between the 1640s and 1680s, before the sciences were subdivided into specializations, and when most scientists had broad interests. Monarchs such as Emperor Rudolf II, King Charles II and King Louis XIV were patrons of the sciences, and the last two encouraged the founding of learned societies: the Royal Society in London (1660) and the Académie Royale des Sciences in Paris (1666). The Accademia dei Lincei had been founded in Rome in 1603. Table 40.1A includes some eminent individuals who were important in advancing bee science or beekeeping during the 1600s. Some of them initiated or facilitated studies on bees; others applied rational thought to improve on the traditional beekeeping methods handed down from past generations.

Two hundred years of trial and experiment passed before a satisfactory and effective rational hive was produced in 1851. During this period a sequence of improved precision-made hives was developed, most of which were made of relatively thin wood and were kept in a shelter or indoors. The sequence was:

1. A modular hive composed of *precision-made tiered wooden boxes* which could be fitted tightly together.
2. A hive containing some sort of framework to which the bees attached their combs. The intention was that the framework could be removed from the

*Dzierzon used the title *Rationelle Bienenzucht* for his 1861 book, saying: 'The rational beekeeper ... conducts his business systematically, ... and has a reason for everything he does.' He added: 'Beekeeping can be carried on rationally only in hives with movable combs.'

Table 40.1A

Eminent scientists and others who played an important part in the history of beekeeping and bee science during the 1600s

Entries are in chronological order of the date of death.

Lived	*Name, and example of interests*	*Country*	*Section*
1552-1612	Rudolf II, Holy Roman Emperor	Austria	40.1
c.1600-1662	Samuel Hartlib, education, agriculture	England	40.2
1614-1672	John Wilkins, mathematics, astronomy	England	37.2, 40.2
1637-1680	Jan Swammerdam, natural history	Netherlands	37.2, 52.2, 52.44, 52.61
1630-1685	King Charles II	England	40.1
1627-1691	Robert Boyle, physics, chemistry	England	37.2
1628-1694	Marcello Malpighi, physiology	Italy	52.2
1626-1697	John Aubrey, antiquary	England	40.6
1650-1702	Willem Hendrik, Prince of Orange	Netherlands	42.22
1635-1703	Robert Hooke, microscopy	England	40.2, 52.2
1620-1706	John Evelyn, horticulture, diarist/author	England	37.2, 40.2
1638-1715	King Louis XIV	France	40.1
1632-1723	Anton van Leeuwenhoek, microscopy	Netherlands	52.2
1632-1723	Christopher Wren, astronomy	England	40.2
1650-1723	George Wheler, antiquary, traveller	England	39.12
1665-1729	Guiseppe F. Maraldi, astronomy	France	37.2, 52.42
1683-1757	René Antoine Ferchault Reaumur, entomology	France	37.2, 52.44, 52.61

hive without cutting the combs, but this was hardly ever achieved.

3. A rectangular or other hive with parallel top-bars placed across the top *at the bees' natural comb spacing*, so that bees built a comb *down from each bar*, and any individual top-bar could be lifted out with its comb. This stage had occurred with traditional top-bar hives, independently in Greece and in Vietnam/China (Sections 39.12, 39.4, 39.52).
4. Each top-bar was *extended to make a rectangular frame* in which bees built a comb.
5. The frame (4 above) was *distanced from the hive walls by the space which bees left naturally between their combs and the cavity containing them*.
6. A practical, easily workable hive with four essential features (printed in italics above); it was relatively inexpensive to make, and robust enough to be kept out of doors.

Discussions of these stages necessarily refer to minute distances, because certain spacings in the hive had to match exactly the dimensions of the body of the worker bees in the hive. In Table 40.6A authors' measurements in inches are converted into metric units (1 inch = 25.4 mm).

Stage 1, the use of precision-made tiered wooden boxes, was probably reached by 1649. Stage 2 followed because of the difficulty in removing combs which the bees had attached to the interior of a Stage 1 hive. Stage 3 was developed separately, from the description of a top-bar hive in Greece published in England in 1682. An attempt to achieve Stage 4 was made in 1683, but failed because the bees' spacing requirements were not understood (Section 40.6). Stage 5 was reached in the early 1800s in Scotland and England, after experimentation in a number of countries (Table 40.6A), and Stage 6 was achieved in the USA in 1851.

Those individuals who published books containing descriptions of their hives had the widest influence on beekeeping, but they have sometimes been credited with making advances that in fact they took over from others. Some details of the lives of the men and women who played a part in these developments, and of the interactions between them, are given in publications cited.

40.2 Tiered round and octagonal wooden boxes for honey production

These hives were rational developments from the earlier upright straw hives used with an extension above or below, or made of tiered rings (Section 38.3). The fact that the wooden boxes were precision-made modules tiered one upon the other led to further advances. Many of the earliest hives were octagonal (Table 40.2A), to approximate to the round cross-section of a natural bees' nest, but in later years simpler rectangular boxes superseded other shapes.

We owe much of our knowledge about three early tiered wooden hives to Samuel Hartlib in England (c. 1600-1662). He was an important pioneer in establishing a network for exchanging knowledge about agriculture, including bees and beekeeping, and Raylor (1992) described his method of working. Hartlib fostered contacts between scientific agriculturalists in England and continental European countries, and these were reinforced when Royalists returned from the continent after the accession of Charles II in 1660.

Hartlib's approach went a stage further than the early beekeeping books written 'out of experience' (Section 27.51). He followed the ideas of Francis Bacon (1561-1626) by promoting scientific enquiries and publishing useful new information gathered from the experiences of different individuals. In 1655 Hartlib produced a book subsidized by the Commonwealth Government, under the appropriate title *The*

Table 40.2A

Development of rational tiered and collateral hives (without movable top-bars or frames) 1649-1843

Hives were constructed on a modular principle, using precision-made wooden boxes. The date is that of a publication, unless in brackets.

	Tiered wooden boxes		*Collateral wooden boxes*
	Octagonal/round (Section 40.2)	*Rectangular* (Section 40.3)	(Section 40.4)
1600s	(1649) Mew[1]		
	(1654) Wren[1]		
	1655 Brown[1] (round)		
	(1672) Gedde[2]		
	1679 Rusden*	1676 Worlidge*	
1700s	1712 Warder*		
	1744 Thorley*	1750 Palteau	1756 White
		1768 Wildman*	1764a Vicat
		1771 Ducarne de Blangy	1781 Dyer
		1796 Keys*	
1800s		1802 Christ	1832 Nutt*
		1827 Bevan*	1843 J. Jones

[1] Hive first published in Hartlib's 1655 book*.

[2] Hive described by Thomson (1673), and by Gedde (1675)*.

* This publication (or a later edition) was in Langstroth's library, and/or was mentioned in his writings; see Section 40.7.

reformed common-wealth of bees,* which included letters from innovative beekeepers such as the Reverend William Mew, Sir Christopher Wren and Dr Thomas Brown.

The date in each italic heading below is that of the first known description of the hive, which was not necessarily published (see also Table 40.2A).

William Mew, 1649

The first hive of interest was devised by William Mew (or Mewe, Mews or Mewes), who was Rector of Eastington near Stonehouse in Gloucestershire from 1635 to 1655 (A.E. Keys, 1964). He was on the Parliamentary side in the Civil War (1642-1646), and preached before the House of Commons in 1643. In 1649 – the year in which King Charles I was executed – he went to attend the Westminster Assembly of Divines, leaving at home 'a Model in past-board' of a structure 'in plain Free-stone' referred to as an 'innocent Phancie'; this seems to have been a stone stand and ornamental cover for an octagonal wooden hive which had glass windows. When Mew returned in 1652, he found that Mrs Mew had arranged for the structure to be made and 'set up in the midst of my Garden; in this I placed an upper and lower Hive' (Mew, 1653b). His idea was to make observations on the bees at work (Section 37.2), and also on the weather by means of various meteorological ornaments placed above the hive. In September, Mew (1653a) wrote about his hive to Nathaniel Angelo 'Fellow of Eaton Colledge', and in December he replied (1653b) to an enquiry from Hartlib saying: 'My Appiary consists of a row of little houses, two stories high, two foot apart.' He could well have used these hives before he left home in 1649.

Samuel, one of Mew's eight children, went to the University of Oxford. He probably did not, as assumed by Fraser (1958), take the hive with him (Raylor, 1992): Mew (1653a) said that he gave the mathematician Dr John Wilkins, who was Warden of Wadham College from 1648 to 1659, 'the Model or Description' – probably of both his hive and the ornamental stone stand for it. Wilkins 'set one up' in his garden, and gave one to John Evelyn in 1654 (Section 37.2). When the Royal Society was founded in 1660, Wilkins became its joint first Secretary. Christopher Wren (below) was also a Founder Fellow. The chemist and physicist Robert Hooke – who had similar hives (Fraser, 1958) – became its Curator of Experiments in 1662, and its Secretary in 1677. According to Plot in 1676, one of the hives was then still in the garden of Wadham. The drawing of Evelyn's hive in Figure 37.2a may well give a good idea of the appearance of Mew's hive with its 'innocent Phancie'.

Christopher Wren, 1654

The drawing reproduced in Figure 40.2a was one of the first architectural drawings made by Christopher Wren, then a Fellow of All Souls at Oxford (Raylor, 1992), who had been at Wadham from 1646 to 1650. It shows a hive based on Mew's, but with three boxes instead of two. Hartlib's 1655 book published the drawing and accompanying notes, with a letter

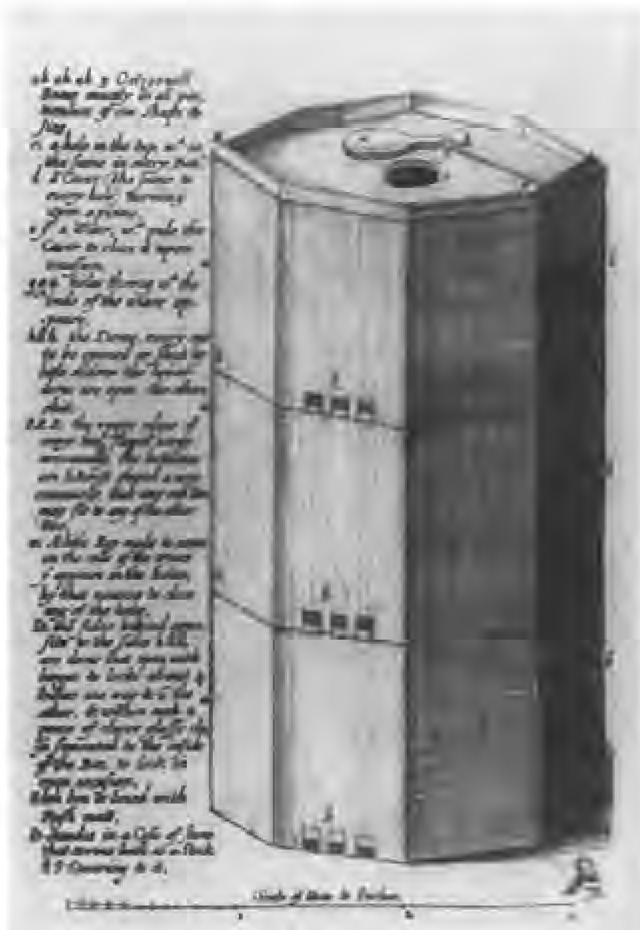


Figure 40.2a Wren's drawing of a hive of tiered wooden boxes, based on Mew's (Wren, 1654).

*The Hartlib Papers Project Phase I at the University of Sheffield (1987-1995) transcribed and edited 25,000 manuscript pages of Hartlib's working papers and correspondence, including material on bees and beekeeping which mostly relates to his 1655 book. The entire archive was published on CD-ROM. Dr Judith Crawford kindly provided copies of the twenty previously unpublished letters to Hartlib which mention bees or beekeeping, and these are now in the IBRA Library. Letters not referred to separately here expressed an appreciation of bees or an interest in beekeeping, or asked how to keep bees in hives.

which Wren had sent him in 1654 describing his use of the hive, but without mentioning Mew.

From the notes at the side of Wren's drawing, we know that in his hive 'the upper edges of every box (KKK) slope away convexedly, the bottoms are likewise sloped away concavely, that any one box may fit to any of the other two'. Each of the identical boxes was open at the bottom, and bees could pass from one to another if the hole (*c*) at the top of a box had been opened by turning its cover (*d*) 'upon a pinne'. Flight entrances, which could be open or closed, are marked *h h h*. There were also observation windows: 'in the sides behind ... are dores that open with hinges and locks, about 4 inches one way and 6 the other; and within each a piece of cleare glass ... to look in upon occasion.' Each box was 'lined with Rushe matt' – perhaps because straw was the usual material for English hives. The hive stood in 'a Case of Stone'.

The management of the bees in these hives was probably similar to that described by Evelyn and later by Gedde (below), but neither Mew nor Wren gave a full description of it. Evelyn (*c.* 1655) said 'there are [those] who make 3 hives [i.e. boxes] succeed one another in this method, by setting a 3rd under the two first (being filled) and when the whole body of the Bees is fully gone down into the third or lowest Box ... the upper hive [i.e. box] be taken away ... and a new empty one put under.'

Dr Thomas Brown, 1655

Hartlib (1655) also published an undated letter 'by that zealous publick-hearted and learned Gentleman Thomas Brown Dr. in Divinity, and of the Civil Law'. This described and illustrated a hive consisting of a tier of three empty wine casks, each holding 'a just bushell [36 litres]', with a base below and a cover above. (The hive shown is cylindrical, with a total height less than three times the diameter, so perhaps only the centre part of each cask was used.) In principle this round hive was similar to the octagonal one in Figure 40.2a. Nothing is known about any communications between Brown and Mew or Wren.

John Gedde, 1672

John Gedde, who had been active in support of King Charles II before the Restoration, made a hive of three tiered octagonal boxes about 1668. In 1672 Sir Robert Moray presented the Royal Society – of which he was a Founder Fellow – with one of these hives 'sent out of Scotland by Sir William Thomson' (Bryden, 1994). In 1673 Thomson described the hive in the Society's *Philosophical Transactions*, but without mentioning Gedde. The Society later acknowledged Gedde's claim to priority, and in 1675 Charles II granted a patent for the hive (No. 180) in the names of John Gedde of Falkland in the Kingdom of Scotland, William Galt and Samuel Nowell.

The Patent stated that the authors had found:

> ... a way for the improvement of bees by the invencon of such comodious hives or boxes, placed the one upon the other, having holes or passages in the topp to lett the bees constantly worke through, and houses with severall entries, backward (and forward), and other conveniencies, which will free the owners from charge and trouble, the bees from the inconveniencies of swarming and being destroyed, and many other casualties that attend them, beyond all expedients that have hitherto bin discovered.

The King commanded that an apiary of Gedde's hives should be set up in Spring Gardens near Whitehall in London, another at Windsor, and one at Falkland Palace in Scotland.

The patent gave no further details about Gedde's hive, but his book *A new discovery of an excellent method of bee-houses and colonies* (1675) included the drawings reproduced in Figure 40.2b, a full description of the hive and instructions for its use. Bees were 'transplanted' into a hive, preferably in early summer, by placing a straw skep containing a strong

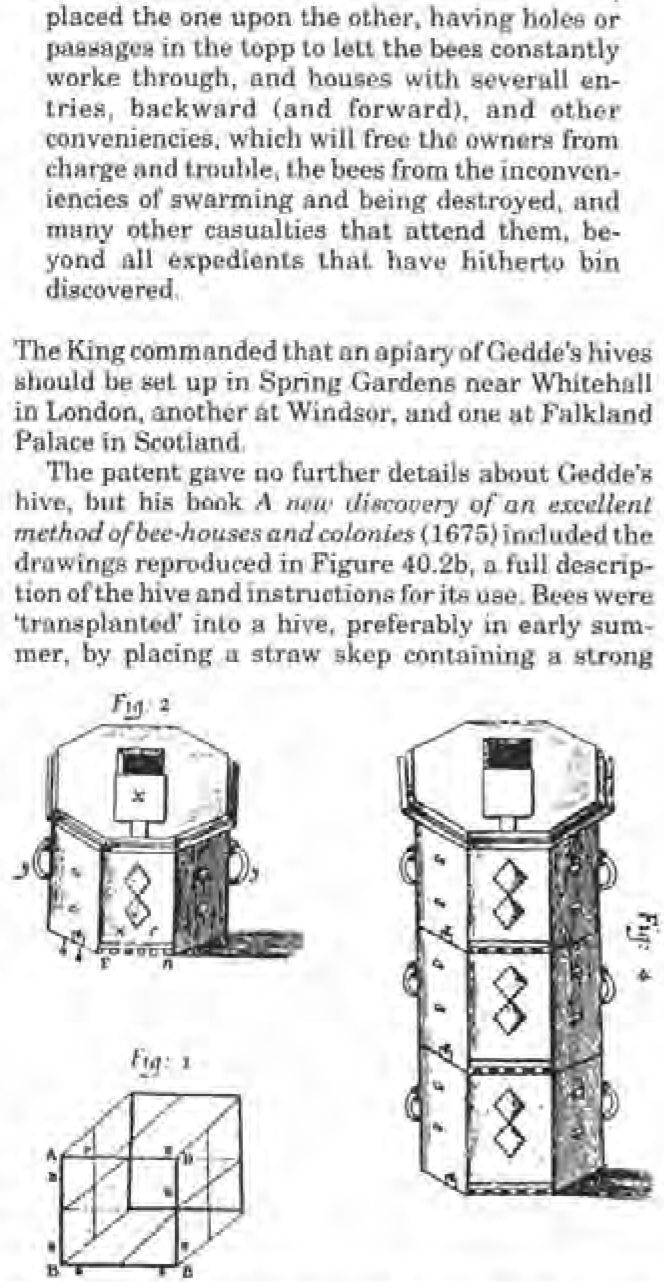


Figure 40.2b Gedde's hive (1675). Fig. 2: One of three identical boxes, very similar to Wren's in Figure 40.2a. Fig. 4: Three boxes tiered, constituting the hive. Fig. 3: 'The frame [i.e. framework] for the bees to fasten their work on'.

colony above one of the boxes, the door in its top having been opened. The joint between the skep and box was sealed with clay, and flying bees could re-enter only through the (open) flight entrance of the box below. When the colony became short of space in the skep it built new combs in the box. When 'the first box is full of Work and Bees' a second box was inserted below the first, with its top connecting door open, and the only flight entrance at the bottom. By the end of the season all the brood would be in the boxes, so the skep was removed and any honey in it was taken. The beekeeper could tell which boxes the bees were working in by looking through windows. A third box was inserted below the two others during the next season, at the end of which only the bottom box would contain brood. To take off the top box, which then contained honey, its flight entrance was opened and the door between the top two boxes was closed. Bees flying out of the top box returned to their accustomed flight entrance in the bottom box. Once inside, they could no longer enter the top box; this could be removed free from bees. The middle box was subsequently removed in the same way.

Gedde's design was similar to that in Wren's drawing with three tiered octagonal boxes, and it seems most likely that he knew about the earlier hives of Mew and Wren but did not say so. Perhaps Gedde's 'new discovery' was the framework to which the bees were supposed to attach their combs (Figure 40.2b, his Fig. 3). He gave instructions to remove 'the inner frame* with the whole fabrick [of combs]'. Worlidge (1669) stated that bees refused to make use of Gedde's frames (Fraser, 1958).

Through Gedde's book, his hive became much more widely known than Mew's or Wren's. The book was republished several times, and the 5th (1721) edition was the basis for several German translations published between 1727 and 1755 as *Apiarium anglicum*; there were Hungarian editions in 1759, 1768 and 1781. Triewald's Swedish beekeeping book referred to at the end of Section 26.32 was published in 1728, soon after his return from England, and his hive was based on Gedde's (Bee World, 1949b). Gedde's hive and method were also described in *La ruche écossaise*. Bryden (1994) told the complicated story of the hive and the Royal Society's connections with it, and Robertson (1990) gave some details of Gedde's life; see also IBRA (1979).

*In modern beekeeping the term *frame* has come to mean specifically a rectangular frame like those in Figure 40.7b (below), inside which the bees build an individual comb. But in the past the word was used for many kinds of structure, and Gedde's 'frame' was a roughly cubical framework in which the bees built their combs.

Moses Rusden, 1679

Gedde made and sold his hives until 1679, when he passed this work on to Moses Rusden who published *A further discovery of bees* in the same year. Rusden was an apothecary, who looked after hives in London (probably those set up by Gedde in Spring Gardens). He called himself the King's Bee Master, a claim regarded with some scepticism until 1965, when John Evelyn's 1660s drawing of his own glass hive was at last published (Figure 37.2a), with his note which says: 'Here set Rusden's new Hive ... whom I got to be sworn the K's beemaster to Ch[arles] II: no such office ever before.' Rusden dedicated his book to the King and described the large ruler in the hive as the King-Bee: 'a fair and stately Bee, having a majestick gait and aspect. ... The King-Bee commands and orders all.'

Rusden's hives were like Gedde's, with a framework inside each box. Rather similar hives were described by Joseph Warder in *The true Amazons ...* (1712), and by John Thorley in *Melisselogia, or The female monarchy* (1744), whose drawings are in principle similar to Gedde's.

40.3 Tiered rectangular wooden boxes for honey production

Rectangular boxes were simpler to make and operate than octagonal boxes, and they were also cheaper. In Italy Gallo (1596) had written about upright rectangular board hives and extension boxes placed below them (Figure 25.2a), and in England John Worlidge (or Woolridge), who also wrote as J.W., described a rectangular tiered hive in *Apiarium* (1676). Each wooden box was 8 inches [20 cm] high, and the box used to start a hive was 12 inches square. Except in cross-section, Worlidge's box module was rather similar to Mew's: it was open at the bottom, with a hole in the top cover, and had glass observation windows. However, extra boxes added below were wider than the first one by 6 or 8 inches, and subsequent ones wider still. He found that colonies given extra space by adding width rather than height grew larger and produced more honey. Worlidge fastened sticks in the hive 'the better to preserve the Combs steady ...', but there was no framework such as Gedde used.

Figure 40.3a shows a possible precursor of Worlidge's system of adding wider boxes at the bottom. It is from an unpublished manuscript by F. Arm, a soldier who had fought on the Royalist side in the English Civil War; most was written while he was

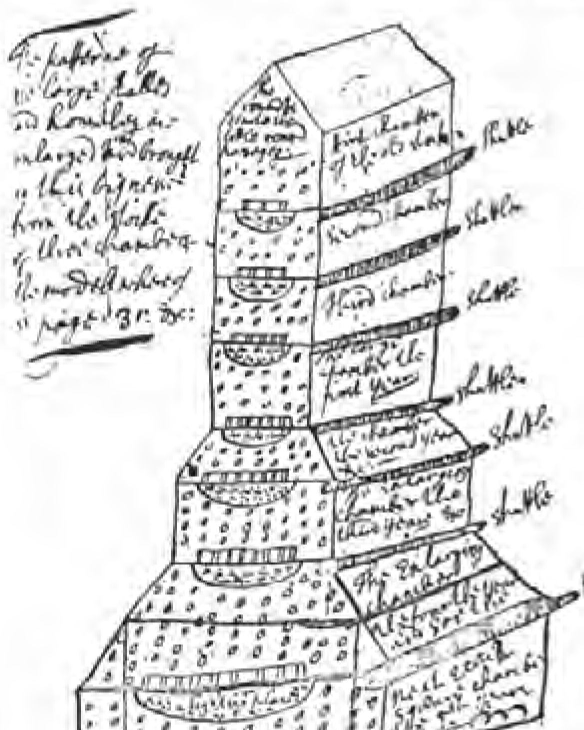


Figure 40.3a Manuscript drawing of a tiered hive by 'F. Arm', 1646/49 (Hoffman & Freeman, 1971). (Arm is possibly an abbreviation.)

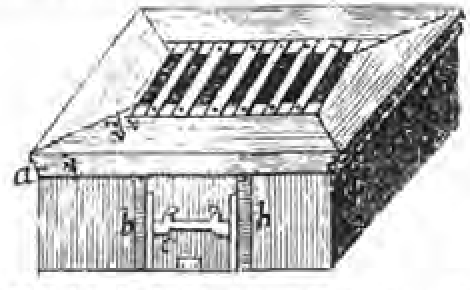


Figure 40.3b Wooden box 9 inches (22.5 cm) square internally, with 6 fixed top-bars, Württemberg (Christ, 1802).

imprisoned in London between 1646 and 1649. I do not know how, or even if, Arm's hive was made or used.

In France, Palteau (1750) described and illustrated a hive of six tiered rectangular boxes, the top one with a window and the others with a flight entrance; Ducarne de Blangy (1771) used a rather similar hive.

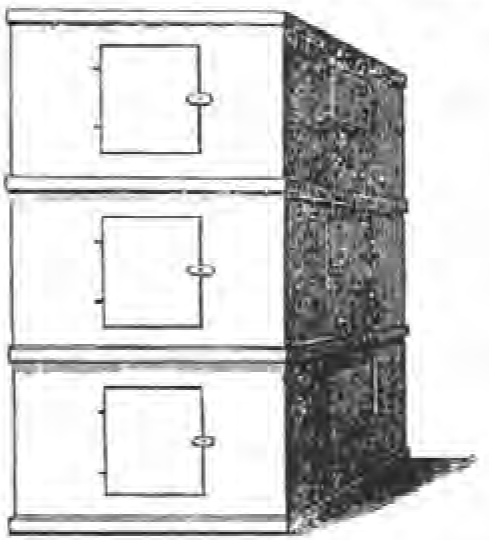
In England, Thomas Wildman (1768) – who was very clever at working with bees – made a wooden hive that was a tall box consisting of two interconnecting 'apartments' one above the other. When combs were to be harvested, or some other operation carried out, 'a slider or cover sliding in a groove' was inserted above, below, and between apartments. In Keys's book (1796) Chapters 8 and 9 were on bee boxes (with bars) and storifying. He used cross-fillets 'to connect the whole like a frame together, to take *in or out*, with the combs fixed to them at pleasure'.

There was less development of tiered hives in German-speaking areas, where combs were harvested from the side or back of a hive. But J.L. Christ (1802) used a tiered hive of up to eight small square wooden boxes with fixed top-bars as shown in Figure 40.3b. He placed the hives with the combs at right angles to the front of his bee house (Crane, 1983a, Fig. 211), so that he could check on the bees by looking along the beeways between combs through a glass window in the front of the hive.

Edward Bevan's *The honey-bee* (1827) described a hive made up of 'a set of boxes' each 12 inches (30 cm) square and 9 inches deep (Figure 40.3c). Each box was fitted with 6 top-bars about 1½ inches wide 'which will leave an interspace between each of about ½ inch'. This gave a centre-to-centre bar spacing of 2 inches (51 mm). A set of boxes had a wooden top cover fixed on with long screws, greased for easy removal. A loose wooden floor was cut away at one edge to provide a flight entrance, which could be closed by pushing a slide along a groove, shown separately in Figure 40.3c. 'The boxes and boards require to be made with great accuracy, that they may be nicely adapted to each other; ... for if there be any crevices the bees will ... fill them with propolis.' Bevan's combs were certainly not 'removable'; he said 'I never saw an instance in which the combs did not either cross those bars at right angles, or connect themselves in some way or other with two or three bars, so as to render it impracticable to remove a comb or two from the outsides.' Bevan thought that combs would be easily removable only 'by employment of the experimental hive of Huber' (Figure 37.3a), which would be too expensive where bees were kept for profit.

Bevan's boxes – unlike Mew's – had no cover turning 'upon a pinne' to regulate the movement of bees between them. Instead he used dividers somewhat similar to those described by Keys (1796): two well hardened (rigid) copper or brass plates, $\frac{1}{16}$ inch (1.6 mm) thick, which – with some difficulty – were pushed in between the (top) box to be harvested and the one below, and Gedde's method described in Section 40.2 was then followed.

In November 1827, a few months after Bevan's *The honey-bee* was published, a builder in Bristol signed a contract to construct and supply six hives and a bee house to accommodate them, all according



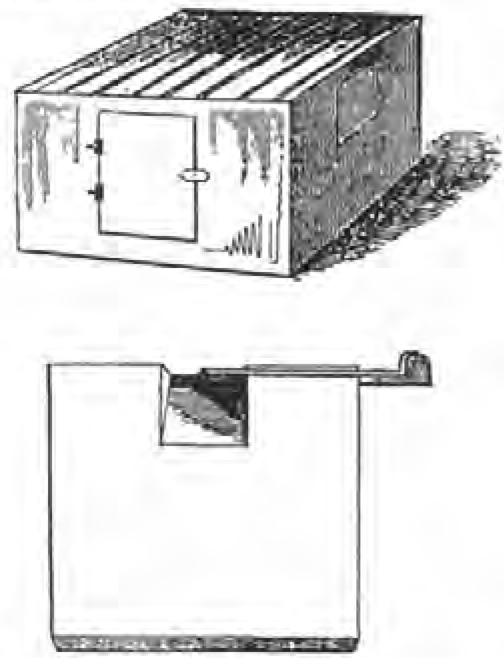


Figure 40.3c Bevan's hive (1827). *left* Tiered hive of three boxes. *right* Single box showing top-bars, and (below) floor board with the flight entrance and the slide for closing it.

to eight detailed dimensioned plans signed by Thomas Jackson. They were to be delivered to Anthony Jackson at Waterford in Ireland. In the 1980s surviving remnants of this bee house, together with the intact plans, were acquired by Clandeboye Estate in Co. Down, and Lady Dufferin had the bee house reconstructed. The plans show that the hives were based on Bevan's; the boxes, six top-bars, entrance slides, and the facility for 'transplanting' bees from a skep as Gedde described, were identical and of the same dimensions. It is likely that metal 'dividers' similar to those referred to above were used when harvesting honey.

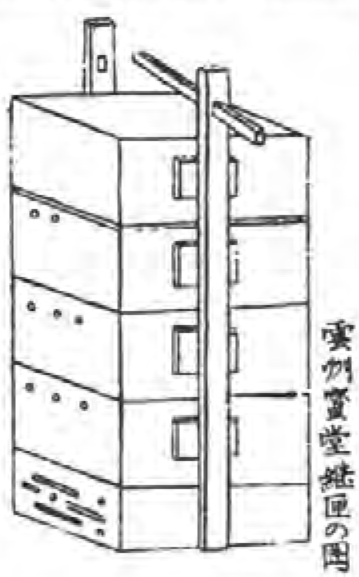


Figure 40.3d Tiered hive for *Apis cerana*, Izumo, Japan (*Hachimitsu-ichiran*, 1872).

Section 40.5 describes Janscha's hive (1771), which could be extended upwards or sideways. Ko Watanabe (1986) referred to a hive of tiered wooden boxes used in Japan in 1872, before the introduction of movable-frame hives (Figure 40.3d). Hives of tiered rectangular wooden boxes finally superseded most others and, fitted with movable frames, they are nowadays the type used in most parts of the world.

Section 31.5 refers to the high honey yields obtained in Australia in the 1840s from a larger version of Bevan's hive of tiered boxes.

40.4 Collateral hives for honey production

In the Mediterranean region, horizontal extensions were traditionally added to hives (Section 38.21). Gallo in Italy (1596) showed a hive consisting of three wooden boxes side by side (Figure 25.2a). In England, Hartlib (1651) referred to such hives in Italy, 'of wine boards: square, in 2 or 3 partitions, standing either above one another, or very close side by side, by the which means they can the better borrow part of their honey when they please'.

In northern Europe horizontal hives were, however, unfamiliar; perhaps for this reason, wooden hives with sideways extensions (collateral hives)

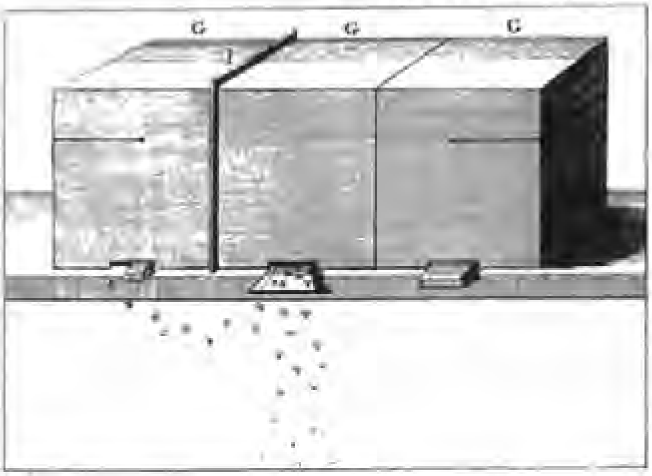
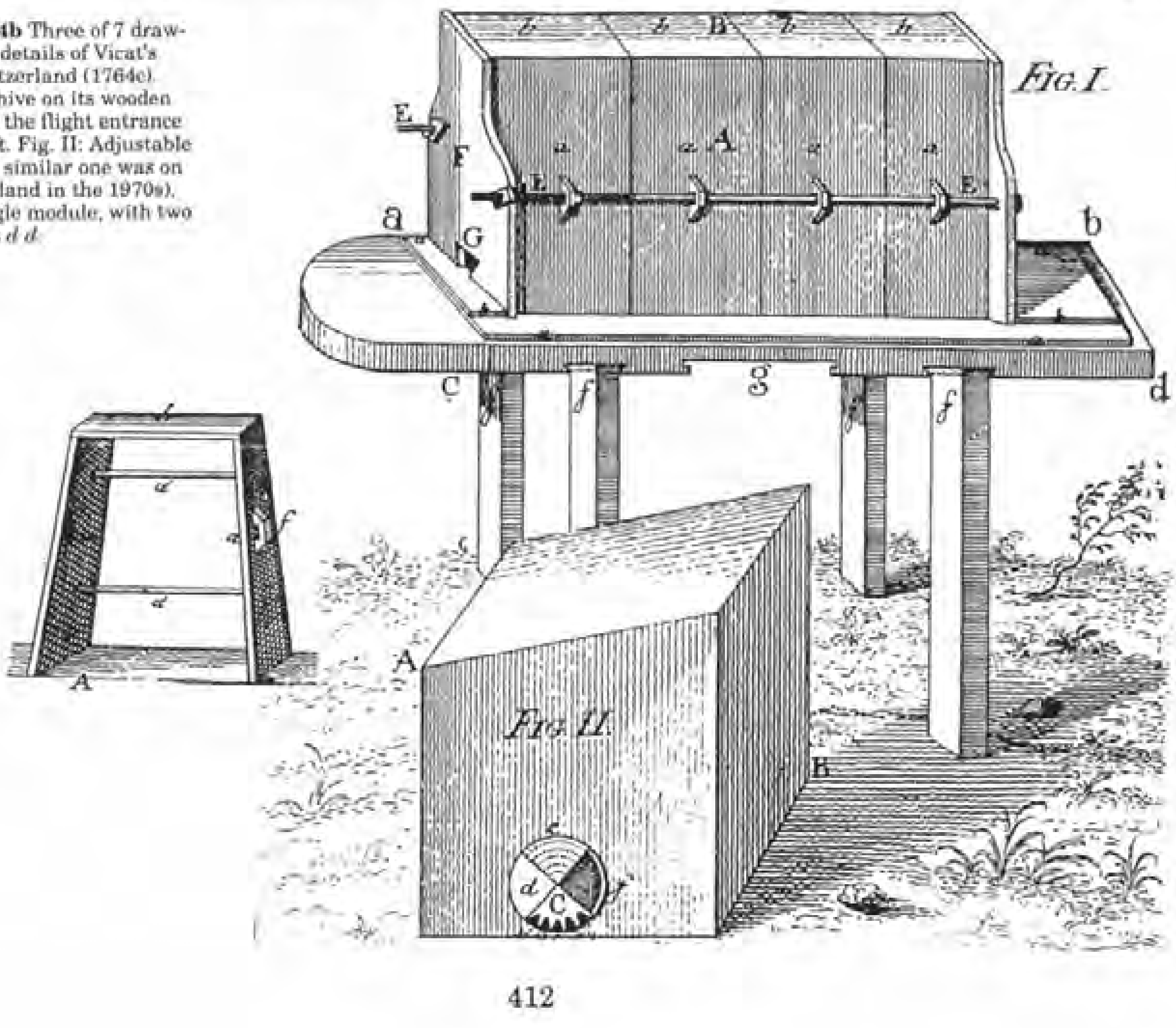


Figure 40.4a Frontispiece to White's *Collateral bee-boxes* (1756). See text for details.

were not used there until a century after tiered hives. A collateral hive consisted of adjacent rectangular (often square) wooden boxes; usually the colony was started in a centre box, and a box at either side was made accessible to the bees later, for storing honey. Bees could move from one box to another through matching slots in adjacent sides, which could be closed when necessary. The first of these hives (Figure 40.4a) was described in the Reverend Stephen White's *Collateral bee-boxes* (1756). Three simple 8-inch (20-cm) cubical boxes G G G were set side by side, each provided with a flight entrance when appropriate. Bees could pass between boxes when a strip of wood at the top and bottom of adjoining sides was removed. When a box was to be harvested, its flight entrance was opened, and the bee passage to the next box sealed off by stapling a tin sheet across it (Figure 40.4a,I), bees leaving this box re-entered the hive through the centre box. The principle is the same as that with tiered hives.

The collateral hive shown in Figure 40.4b was devised in Switzerland by Cátherine Elisabeth Vicat (1764a, 1764c). It was built of modules each 28 x 13 cm, 18 cm wide at the top and 25 cm at the bottom; the modules were kept in place by two long rods E E. To remove combs from the end module on the right,

Figure 40.4b Three of 7 drawings giving details of Vicat's hive in Switzerland (1764c). Fig. I: The hive on its wooden stand, with the flight entrance G at the left. Fig. II: Adjustable entrance (a similar one was on sale in England in the 1970s). *on left*: Single module, with two cross-sticks *d d*.



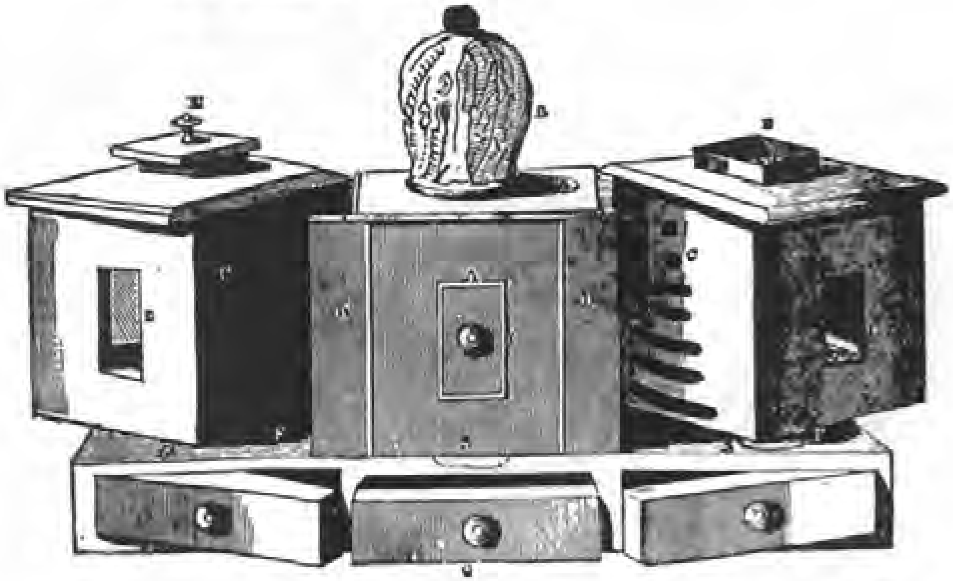


Figure 40.4c Nutt's collateral hive, opened out to show its separate parts (1832). See text for details.

that end board was removed and bees smoked towards the entrance G on the left, then the end module was loosened from the next one. If the combs had been built along the hive they were cut through with a wire or sharp thin knife; if they were built crosswise they were taken out singly before the module itself was removed. In England Wildman described this hive in 1768, and in 1781 W. Dyer published *The apiary laid open, or An advantageous treatise on the construction and use of retrocoupling bee boxes (a new invention)*; only two copies survive (IBRA, 1979).

Thomas Nutt's collateral hive became well known, because his 1832 book was widely read and much translated during the 1830s: into three German editions, and a Portuguese and a Hungarian one. In Figure 40.4c the hive is spread apart to show the slots through which the bees moved into side boxes, and also a bell jar full of comb honey standing above the central box. Underneath, the middle drawer was for feeding, and each 'block front' at the side incorporated a flight entrance to the box above it. In Figure 40.4d the hive is set up for use, with a glass jar above each side box, and a central upper box, all for honey. The hive shown is one of four which still exist in England (Crane, 1983a), and another is known in Hungary where Kövesdi-Szarka (1844) described its use (Örösi-Pàl, 1968).

Figure 40.4d Surviving example of Nutt's hive (IBRA Collection B65/5).

A book that appeared in 1843, *The eclectic hive* ... by John Jones, described beekeeping with other collateral hives. Two of his hives, encased in wooden Gothic outer structures, were photographed in use in Herefordshire in the 1920s (Crane, 1983a, Fig. 231).

40.5 Hives for making new colonies

The traditional long box hive of Carniola in Slovenia is described in Section 25.6. Anton Janscha adapted it, making a very versatile hive by treating the box as a module and using two or more boxes in conjunction. Boxes had removable sides, and interconnecting holes which could be closed off. The hives were described and illustrated in Janscha's 1775 book (Figure 40.5a), and Figure 35.2c shows a stack of the boxes on a cart. By using these hives Janscha could unite colonies, and also prevent swarming and so obtain larger colonies and higher honey yields. He

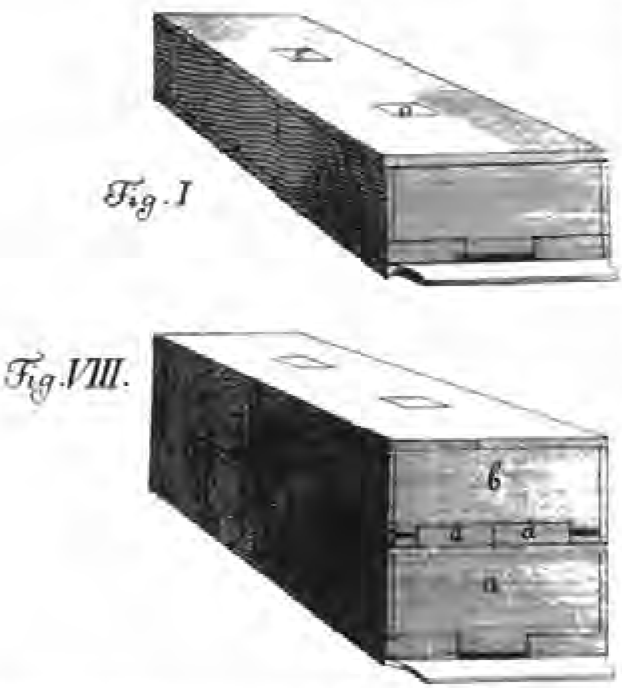


Figure 40.5a Janscha's hive boxes (1775). Fig. I: Single box, closed. Fig. VIII: One box superimposed on another to make a larger hive.

devised six methods for dividing a colony by making an 'artificial swarm'. For instance, when a colony in one box became strong in spring, he placed above or below it an empty box containing a comb of honey, leaving open the communicating hole and also both entrances. When the added box contained enough bees, brood and honey, he closed the hole between the two, and introduced a queen to the box without one. Janscha described how to produce and introduce queens. He was very inventive, and had great beekeeping skill; Fraser (1950) called him 'the greatest practical beekeeper of past times'. He used various features of his hive in combination to carry out many different operations, of which precise details have been published (Janscha, 1771, 1775; Fraser, 1951b).

The hive developed by Jonas de Gélieu in Switzerland (1772) was a long box with a cross-section 10 inches square (25 cm); he made an artificial swarm by means of fitments in this hive. He placed the hive on a wooden board 'provided with 12 wooden pins 4 or 5 inches long ... in two rows' 3 inches apart, and wedged a piece of comb between adjacent pairs of pins, to provide a space between the combs 'about the same as those in the hive to allow free passage of the bees'. He also inserted small pieces of wood to keep the combs off the floorboard. The four outer combs contained honey, and in the centre he placed a piece of comb cut out from a strong colony, containing 'eggs, nymphs but principally the little maggots, just 2 or 3 days out of the shell'. Adult bees from the colony were added, and they reared a queen. Gélieu also made new colonies by using a Greek top-bar hive.

In Scotland, James Bonner published *The bee-master's companion and assistant* in 1789, and *A new plan for speedily increasing the number of bee-hives in Scotland* in 1795. He recommended Gélieu's hive, and described a box of somewhat similar shape and size, divided into two parts joined by bee passages through the divider. Each compartment could be closed off, or enlarged by adding another box to it. Bonner used this hive to carry out some manipulations similar to Janscha's, although he had probably not heard of Janscha's system. Clementine Stirling Graham translated Gélieu's 1772 book into English (1829, 1876); she said that his father wrote a book on the same subject in 1746, but did not publish it. Sooder (1952) gave details of the Gélieu family history.

40.6 Rational top-bar and frame hives, 1680s-1850s

This Section explores the development of rational hives based on the concept of the traditional Greek top-bar hive described in 1678, with combs that could be lifted up singly by the top-bar and were thus 'movable' (Section 39.1). Table 40.6A summarizes certain features of hives mentioned in the text, few of which had all the characteristics required in a movable-frame hive, listed on pp. 405-406. When end-bars and a lower horizontal bottom bar were added to the top-bar to make a frame, a crucial requirement of the hive was the correct 'bee-space' between the frames and the hive walls as well as between adjacent comb surfaces.

J.A., 1683

Wheler's 1682 account of the Greek movable-comb top-bar hive (Section 39.12) was followed on 16 June 1683 by a detailed description of a hive based on it, with a rectangular cross-section – so that all top-bars had the same length – and in which each top-bar was extended to form a frame. The diagrams of the hive in Figure 40.6a were made in 1928 from the description published (without a diagram) by J.A. in a London periodical, *A Collection of Letters for Improvement of Husbandry and Trade*. The title was

Table 40.6A

Development of rational movable-comb and movable-frame hives, 1683-1853

The individual hives are discussed on pp. 416-422.

The date is that of a publication, unless in brackets. Hives are rectangular unless otherwise stated.

The minimim centre-to-centre spacing between top-bars or frames which allows European *Apis mellifera* to build regular brood combs from them is likely to be about 32 mm, and the maximum perhaps up to 41 mm ($1\frac{1}{4}$-$1\frac{5}{8}$ inches). The bees accept a larger spacing for honey-storage combs, up to about 48 mm ($1\frac{7}{8}$ inches) or more.

The 'bee-space' to be allowed between facing comb surfaces is about 8 mm.

Date	*Name, Country*	*Bar or frame*	*Centre-to-centre top-bar spacing* inches	mm	OK	*Frame-to-wall spacing OK*	*Hive tiered (T)*
1683	J. A., England	frame	2	[51]	no	no	–
1700							
1768	Wildman*, England (round)	bar	$1\frac{3}{4}$	44	no	–	–
1790	Rocca*, Syros	bar		c.44	honey, yes	–	T
1792	Huber*, Switzerland	frame	$1\frac{1}{4}$	32	yes	–	–
1800							
1804	Playfair, Scotland	frame	$1\frac{1}{2}$	[38]	yes	no	–
(1814)	Prokopovich, Russia	frame		44	honey, yes	no	T
(1819)	Ker at Stewarton, Scotland (octagonal)	bar/frame	$1\frac{7}{16}$	[36.5]	yes	yes	T
	(octagonal)	bar/frame	$1\frac{7}{8}$	[48]	honey, yes	yes	T
1827	Howatson, Scotland	bar	$1\frac{1}{2}$	[38]	yes	–	T
(1834), 1844	Munn*, England	frame	$1\frac{5}{8}$	[41]	yes	yes	–
1846	Debeauvoys*, France	frame		32-37	yes	yes?	–
1847	Golding*, England (round)	bar	$1\frac{5}{8}$	[41]	yes	–	–
1847	Shaw, USA	frame	$1\frac{1}{2}$ - $1\frac{3}{4}$	[38-44]	yes	no	–
1851	Munn*, England (triangular)	frame	$1\frac{5}{8}$?	[41?]	yes	yes	–
1848	Dzierzon*, Germany	bar	$1\frac{1}{2}$	[38]	yes	–	T
(1851), 1853	Langstroth, USA	frame	$1\frac{1}{2}$	[38]	yes	yes	T
1853	Berlepsch, Germany (see Section 41.3)	frame	$1\frac{1}{2}$	[38]	yes	yes	T

Observation hives are in Chapter 37.

* This publication (or a later edition) was in Langstroth's library, and/or was mentioned in his writings, see Section 40.7.

'Directions for the Making of Colonies for Bees, and by a new invented Model of Hive, to improve them, whereby without killing, may be enjoyed the Fruit of their Labour.' This hive provides a foretaste of developments in the 1700s and 1800s, but it seems to have been unknown to beekeepers who later tried to devise better hives, including Langstroth. H.J.O. Walker (1928) found only one other previous reference to J.A.'s hive, by John Aubrey in the *Natural history of Wiltshire* which he wrote about 1690. He described it as a 'good modelle of bee-hive', and this suggests that J.A. was John Aubrey himself.

J.A.'s description included the passage:

> ... in each of which Frames it is designed that the *Bees* should fix a *Comb*, beginning at the top of the Box on the under side of the cross sticks; which frames, when wrought full to the bottom, will each of them contain an intire *Comb* of the whole breadth and depth of the Hive or Colony, and by this means you may at your Conveniency (first taking off the top Board or Plank) draw out a whole *Comb*, it not being wrought to the sides, but in the frame, and the lower end being narrower than the upper, it will come up with ease, so that in the *Spring*, when you would increase the Number of your Hives, and make two of one, you may, and thereby prevent their *Swarming*, which in Graece is in this manner practised.

The top-bars of J.A.'s frames were $1\frac{1}{2}$ inches wide, and he left $\frac{1}{2}$ inch between them, giving centre-to-centre comb spacing of 2 inches (Table 40.6A) – acceptable to the bees for honey storage but too wide for worker brood. Also, his frame end-bars were too tight against the hive walls, and the bees would attach the two together.

H.J.O. Walker (1928) reprinted J.A.'s letter, with his own comments as well as the diagrams in Figure 40.6a. He thought that J.A. would later have realized the need to leave a space between the frames and

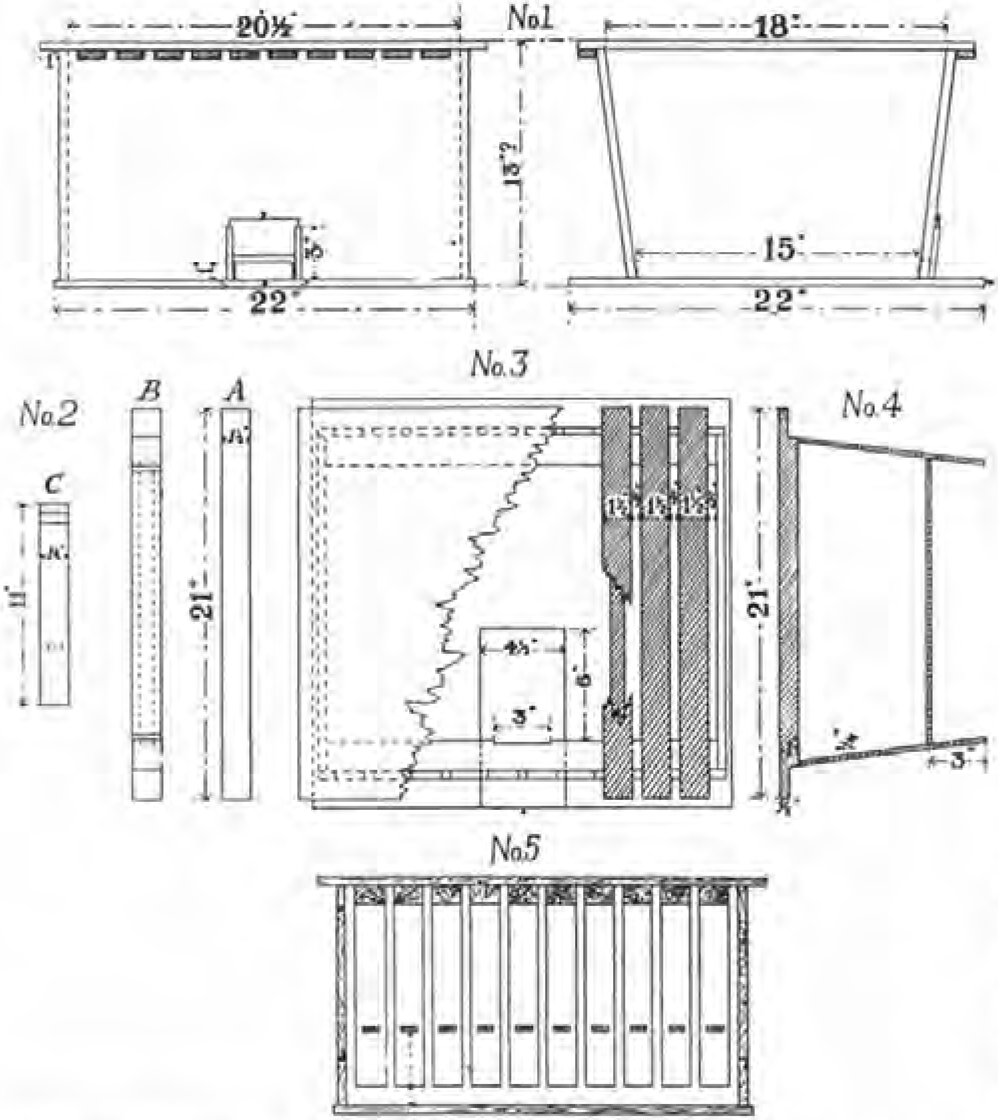


Figure 40.6a J.A.'s frame hive with sloping sides (1683), drawn by Walker (1928). J.A. stated all dimensions except the height; Walker assumed this to be 12 inches internally, 'which gives the necessary Grecian slope'.

1 Front and side elevations
2 A, B, Top-bar of frame
C, End-bar of frame
3 Plan of hive
4 Assembled frame
5 End elevation of frames *in situ*

hive sides, and that 'the spacing between the frames might well be altered'. He added: 'I can see nothing else to find fault with; the hive was a wonderful feat of imagination.'

Like Wheler, J.A. failed to understand the need for top bars or frames to be spaced appropriately for the bee's body size. During the next 85 years, interest centred on the boxes of which a wooden hive was made and their relative positions (Table 40.2A), and no record has been found of further developments with top-bar or frame hives (Table 40.6A). Perhaps any individuals who might have turned their minds to the bees' comb spacing, and experimented further, did not read either Wheler's or J.A.'s publication.

Thomas Wildman, 1768

Wildman quoted *verbatim* Wheler's 1682 account of the Greek top-bar hives, including the paragraph reprinted in Section 39.12. But he, also, did not understand the criterion for top-bar spacing. He described a hive (Plate II, Fig. 5) consisting of a shallow coiled-straw cylinder with bars across the open top, but too far apart and fixed in place. A stick through the middle of the hive steadied the combs after these were built.

Abbot della Rocca, 1790

The rectangular top-bar hive shown in Figure 40.6b was devised by della Rocca when he lived on the Aegean island of Syros. He described it in his Volume

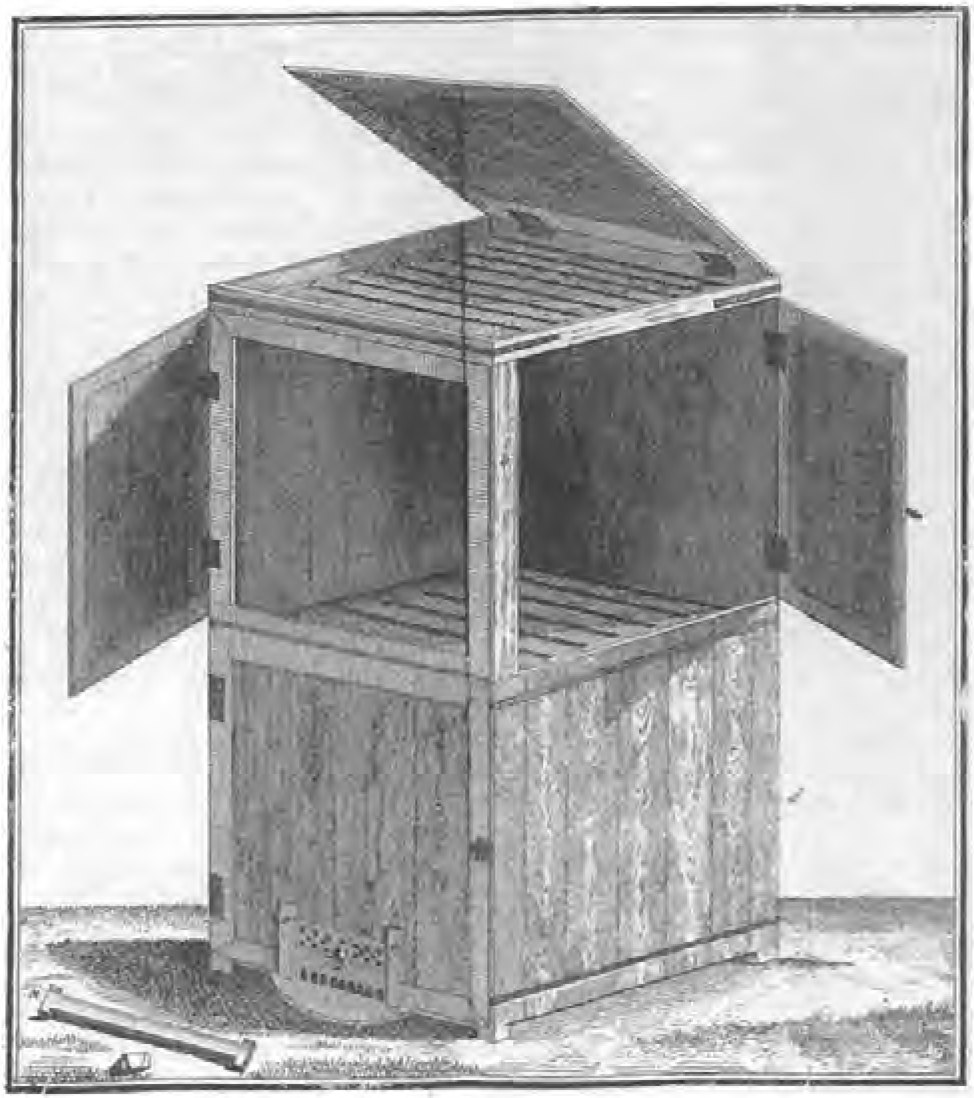


Figure 40.6b Abbot della Rocca's hive (1790).

2 (pp. 467-469), and said on page 498: 'une ruche que j'ai imaginée pour la multiplication des essaims, d'après la méthode ... des habitans de Candie [Crete] d'aujourd'hui.' It had two identical boxes 1 x 1 x 1 foot (30 cm). He said that the hive held 9 top-bars, although he gave the centre-to-centre separation as 20-21 lignes (43.3 to 45.5 mm) which would allow 7; in his drawing, 8 can be seen above and 6 below. Della Rocca's text makes it clear that he understood the need to adhere to the centre-to-centre top-bar spacing required by the bees.

François Huber, 1792

Huber's leaf hive (Section 37.3) was designed for observation and experiment, not practical beekeeping. Combs were built in correctly spaced frames that could be separated like the leaves in a book, as shown in Figure 37.3a.

James Playfair, 1804

Playfair, a minister in the Church of Scotland, wrote a 290-page manuscript *On the care and knowledge of bees* which still exists but was never published. The book, summarized by Tennent (1951), contains drawings and a description of Playfair's hive: a 12-inch (30-cm) cube of wooden boards, holding 8 frames whose top-bars projected beyond the hive walls. A $\frac{1}{2}$-inch space was left below the frames and, if a glass cover was used, a $\frac{1}{4}$-inch space above them. The space between frames was satisfactory for the bees, but the side-bars were only $\frac{1}{10}$ inch from the hive walls, which was too close.

Peter Prokopovich, 1814

In Russia, twigs had sometimes been laid across the top of a (log) hive, under the hive cover, for the bees to attach their combs to (as in Brač, Section 38.33). Some later beekeepers used strips of wood or pieces of dry comb, but not in any systematic or logical way. A more rational hive was made by Peter Prokopovich, who was born in 1775 of poor parents and was not highly educated. He started beekeeping with a few hives in 1800 after he left the army, and by 1808 he had 580. In 1828 he opened a beekeeping school which continued for fifty years; most of his students were peasants and some were illiterate. Prokopovich is regarded as the father of modern beekeeping in Russia. His main work, entitled 'Notes on beekeeping', consisted of twelve books, all of which were completed and officially approved, but they were never published. He bought the equipment to have them printed under his own direction, but was not allowed to proceed and, feeling undeservedly insulted, he refused to publish them elsewhere, and after his death they were lost (Bilash, 1995). However, Prokopovich published more than fifty articles on beekeeping in Russian journals; in 1841 an article describing his hive was translated into French, and another by Pokorsky-Zhoravkoa described it in German.

Many accounts of the hive were published after his death. They vary considerably, which Butkevich (1928) ascribed to the fact that Prokopovich worked on the hive for many years (and probably used different models), always fearing that other beekeepers would take his work and distort it. Referring to Figure 40.6c, the hive – which was opened from the back like a trunk hive – had three compartments each with its own door. Bees built brood combs in the lower two, without any bars or frames; a central hole in a division board that separated them could be left open or closed, as in some English hives used in the 1600s (Section 40.2). The upper and middle doors have been removed to show combs of brood and, above them, wooden frames for honey combs; these had no lugs for suspension and had the appearance of 'sections' devised later (Section 43.1). Prokopovich understood the requirements for the spacing between combs (Bilash, 1995), and the 'sections' were of the correct breadth, but they came close to the hive walls – to which the bees attached them – so they had to be cut out. Prokopovich kept the queen out of the honey compartment by inserting a queen excluder below it (Section 43.3). About 10,000 of his hives were made altogether, but Prokopovich himself continued to use log hives as well (Galton, 1971).

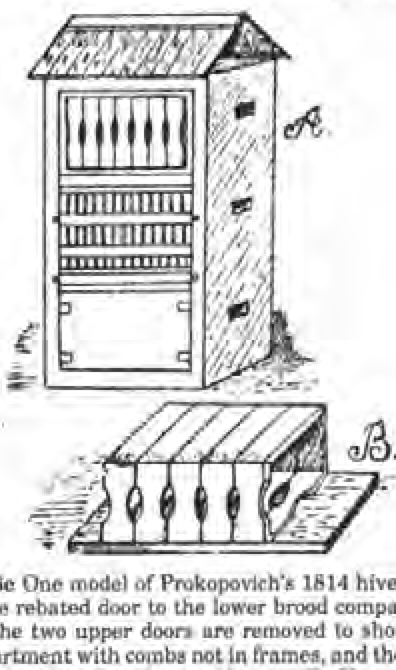
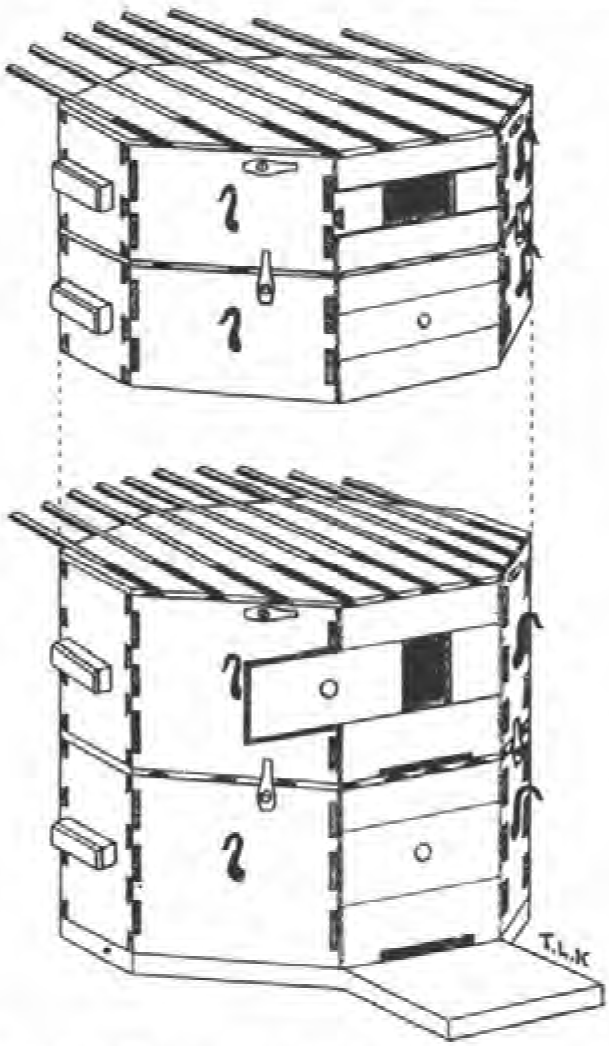


Figure 40.6c One model of Prokopovich's 1814 hive (Butkevich, 1928). **A** The rebated door to the lower brood compartment is in place, and the two upper doors are removed to show the upper brood compartment with combs not in frames, and the (top) honey storage compartment fitted with frames. **B** Close-up of honey frames.

Robert Ker's Stewarton hive, 1819

Robert Ker, known as Bee Robin, was a cabinetmaker. In 1819 he designed and constructed hives of a type named after Stewarton near Ayr in Scotland where he lived (Figure 40.6d). Details were published by Bartrum (1881), Beveridge (1941) and Struthers (1951). He used tiered octagonal boxes, 14 inches (36 cm) wide and 7 or 8 inches deep, which had glass inspection windows. Nine removable top-bars were screwed in place across the top of each deep box (*left, below*), and frames were added to the four central bars so that their combs could be interchanged 'with a little trouble'. The top-bars were spaced correctly for brood combs (at $1\frac{7}{16}$ inches, 36.5 mm), and the bees started their combs along a thin strip of wood fixed centrally underneath each top-bar. Herrod-Hempsall (1930) published photographs to show that 'the inventor of bar-frames for the Stewarton hive' first made them long enough to fit tightly into their box (and these had to be cut out); he later adjusted their length to leave $\frac{1}{2}$ inch between frame and hive sides – across which the bees built brace comb – and finally $\frac{1}{4}$ inch.

Ker usually added up to four shallow (4-inch) octagonal honey boxes (Figure 40.6d, *left, above*), fitted with seven top-bars which were more widely spaced. Suitable management, which included sliding fillets of wood along grooves between adjacent top-bars above the brood box, kept the queen out of the honey



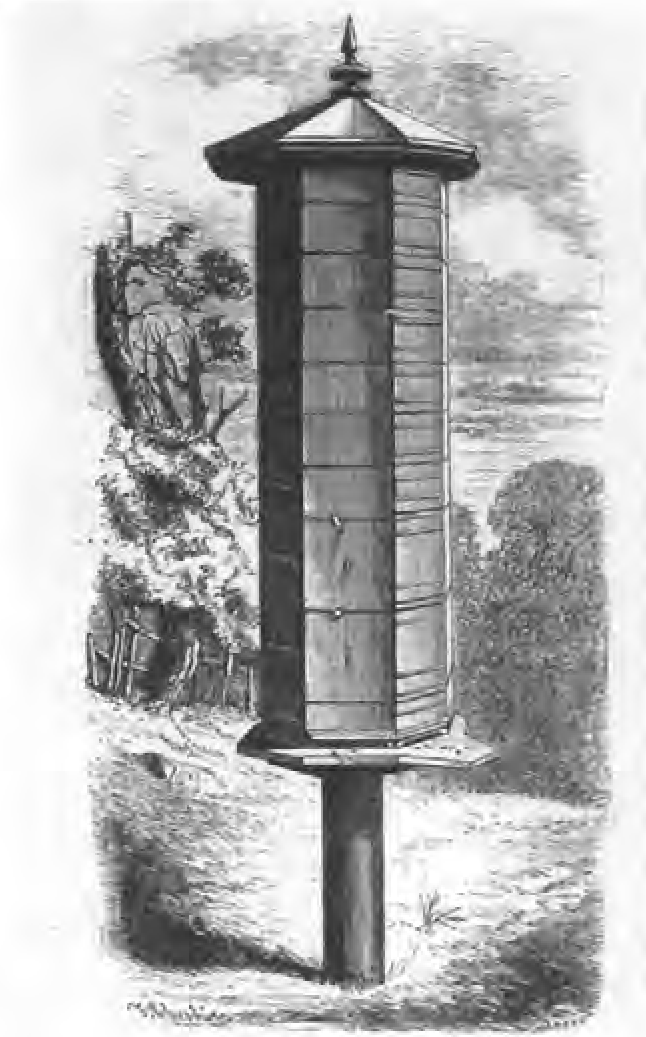


Figure 40.6d Stewarton hive, 1819. *left* Drawings of 2 deep and (above) 2 shallow boxes (Struthers, 1951); see text. *right* Hive with 2 deep and 7 shallow boxes 'in full work' (Bartrum, 1881).

boxes. A shallow box held 20 lb (9 kg) of honey, and when full he separated it from others with cheese wire. In 1874, Scots beekeepers took exhibits weighing nearly half a ton to the first great Honey Show held at the Crystal Palace in London, and their entries 'swept the board; the pride of the Show came from Ayrshire, in octagon Stewarton hive supers ... the combs so beautifully straight and symmetrical, and as perfectly finished as if they had been cast in a mould ... Within a month of the triumphant return from London, ... a National Scottish Bee Association was formed.' The Stewarton hive was used widely in Scotland until a standard movable-frame hive was introduced in 1882.

T.M. Howatson, 1827

Howatson made a hive of two boxes, each internally 12 inches across and 8 inches deep (30, 20 cm), and fitted with eight top-bars. 'Slips of glass' $\frac{1}{8}$ inch wide separated the bars, and those in a lower box were removed when an upper one was added. If a 4-inch upper box (instead of an 8-inch box) was added 3 weeks after a swarm was hived, the bees would then readily build combs in it 'which may be sent any distance to market in the half boxes without receiving any injury, merely by laying them in a cart on a quantity of hay or straw'. When a swarm issued from a hive, a second box was immediately added, and this prevented the colony 'throwing a second swarm'.

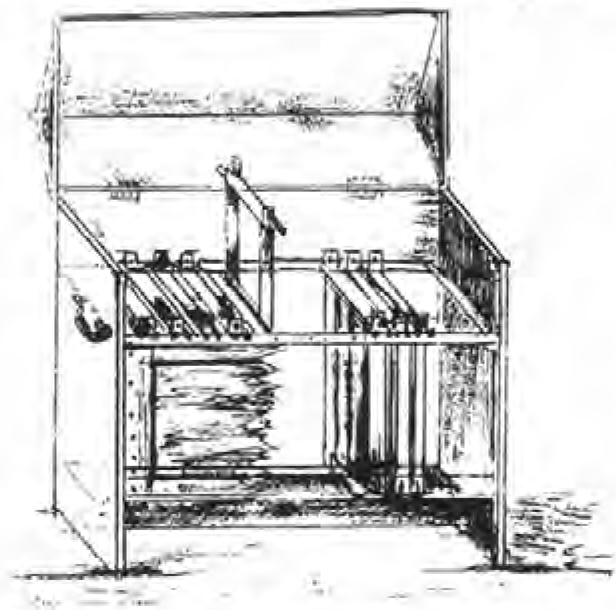


Figure 40.6e Drawings of two of Munn's hives. *left* 1834 hive; part of the near hive wall is cut away to show 3 frames *in situ*, and one partly lifted out (Bevan, 1870). *right* Hive with triangular frames that move on a pivot (Munn, 1851).

Augustus Munn, 1834, 1844, 1851

Major Munn's 1834 hive (Figure 40.6e, left) was described in the first edition of his book (1844). Herrod-Hempsall (1930) called this hive, 'a true hanging bar-frame hive', and said that it was patented in France in 1838. Langstroth marked two passages in his copy of Munn's book:

> A half inch space nearly all round them [the frames].
>
> The frames with their contents can be lifted out ... whenever it is wished to examine the bees, &c., as the half inch spaces between the bee-frames will allow of a sufficient distance to be preserved between the lateral surfaces of the perpendicular combs formed in the 'bee-frames' and this permits them to lift out by each other with facility.

Munn invented another hive, rather elegant but not very practical (Figure 40.6e, right). He described it in the second edition of his book (1851), and also in his 1870 revision of Bevan's 1827 book. All the spacings of Munn's frames were right, but his hives were not tiered.

J.B. Debeauvoys, 1846

In France, Debeauvoys published a description of a rectangular hive with nine frames 20-25 mm broad, separated by a space of 12 mm 'which must not be disturbed', and distanced from the hive walls by 5 mm; Debeauvoys said there was little or no attachment to the walls (5th ed., 1856).

Robert Golding, 1847

Robert Golding was a Kent beekeeper whose *Shilling bee book* described an 'improved Grecian hive' with top-bars in 1847. This hive was similar in shape and style to the one illustrated by Wheler in 1682 (Figure 39.1a), but was made of coiled straw, and intended for use with a honey chamber above. Like della Rocca, Golding explained the need to allow the correct spacing between combs.

> The bars should be half an inch thick, $1\frac{1}{4}$ wide, and seven in number. If properly adjusted, there will be interspaces between them of about half an inch ... The general fault of those who adopted bars was, that they made them too wide, so that the bees – of course adhering to their own rules – building regularly throughout, often attached two combs to one bar; or built across the intervening spaces.

Jacob Shaw, 1847

In 1847, *Scientific American* published a letter by Jacob Shaw of Hinckley, Ohio, describing a new movable-frame hive, for which he claimed seven advantages. These included:

- by attaching guide combs to the bars of the frames, the bees are induced to attach those which they build each to a separate frame.
- these frames with the combs attached may be removed at pleasure.
- the combs may be renewed by removing the frames that are filled and supplying their places with those that are empty, when the bees will re-load them.

The wooden frames ($1\frac{1}{8}$ inches wide and $\frac{3}{8}$ to $\frac{5}{8}$ inch apart, giving a comb-spacing 38-44 mm) were fitted with a cross-bar half-way up, as well as a bottom bar and end-bars.

Unfortunately other features of Shaw's hive made it impractical. It was made entirely of metal, and was surrounded by an outer box into which hot fluid was poured to 'disengage' the frames 'without cutting the combs'. Dimensions were chosen to 'allow the frame to slide into the inside box, the posts [end-bars] touching its sides'.

Johannes Dzierzon, 1848

Johannes Dzierzon (1811-1906, Figure 40.6f) was a pastor in Silesia who became known in German-speaking countries as the father of modern beekeeping. Brozck *et al.* (1978) wrote a full biography. Dzierzon could probably read only Polish and German, and many of the developments in other countries were unknown to him. Even the 1878 edition of his book *Rationelle Bienenzucht* – which described a number of German hives – did not mention Langstroth's from 1853.

Dzierzon was familiar with the large log hives worked through a door in the side (Figure 26.2e). He knew about Prokopovich's hive from the 1841 German article, and he devised tall hives of wooden boards worked from the back (see Figure 40.6g,B). In 1848 he described such hives (also published earlier, 1845b) fitted with one or more tiers of top-bars from which the combs were built (Figure 40.6g,A,B); he said that the width of a top-bar must be $1\frac{1}{2}$ inches [38 mm], as this is the distance taken up by a comb together with the space between adjacent combs. Figure 41.3b shows Dzierzon types of hives.

In 1850 or 1851 Samuel Wagner in the USA had

Figure 40.6f Pastor Dr Johannes Dzierzon, 1885 (Museum im. Jana Dzierzona, MK-Dz-1492).

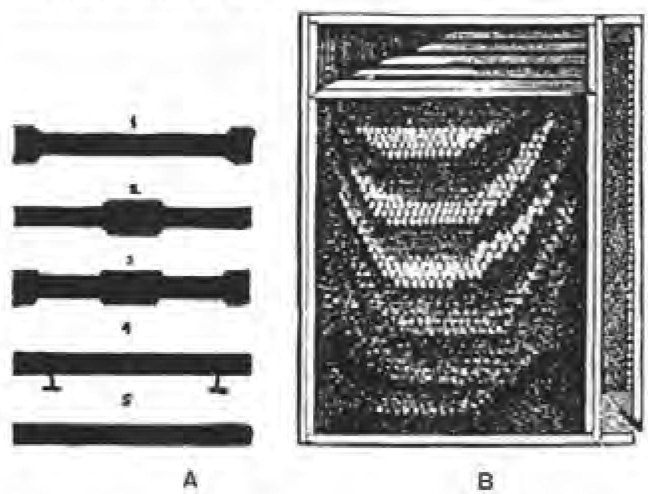


Figure 40.6g Dzierzon's drawings of his movable-comb hive and accessories (1861). **A** Five designs of top-bars, 1-4 with spacing devices. **B** Top-bars with combs, viewed from the opened side of the hive.

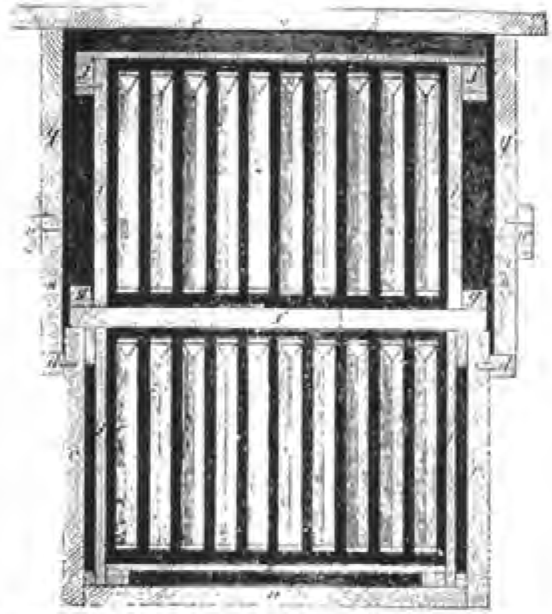
made a translation of Dzierzon's 1848 book. Before it was published, he visited Langstroth's home and apiary, with the result that he urged Langstroth to write and publish a book on his own methods and experiences, in place of the translation of Dzierzon's book (Naile, 1942).

40.7 The first practical hive with movable frames

The Reverend L.L. Langstroth (Figure 40.7a) started beekeeping in 1827 with two box hives, and later also used a leaf hive like Huber's. He owned and mentioned in his writings many books describing earlier hives (marked in Tables 40.2A and 40.6A); see Johansson & Johansson (1972b). But he seems not to have known the frame hives of J.A. (1683, Figure 40.6a) or Jacob Shaw (1847).

In 1851 Langstroth adapted Munn's 1834 hive in ways that made the final advance to a practical movable-frame tiered hive: he incorporated Munn's correct comb spacing, and also a bee-space above and below frames, and between frames and hive walls. Figure 40.7b shows the structure of the hive and the bee-spaces. Johansson and Johansson (1967a) discussed thought processes that led Langstroth to this hive, in the light of his unpublished notes and his 1853 book which contained the following passage.

> Pondering, as I had so often done before, how I could get rid of the disagreeable necessity of cutting the attachments of the combs from the walls of the hives ... the almost self-evident idea of using the same bee space as in the shallow chambers came into my mind, and in a moment the suspended movable frames, kept at a suitable distance from each other and the case containing them, came into being. Seeing by intuition, as it were, the end from the begin-



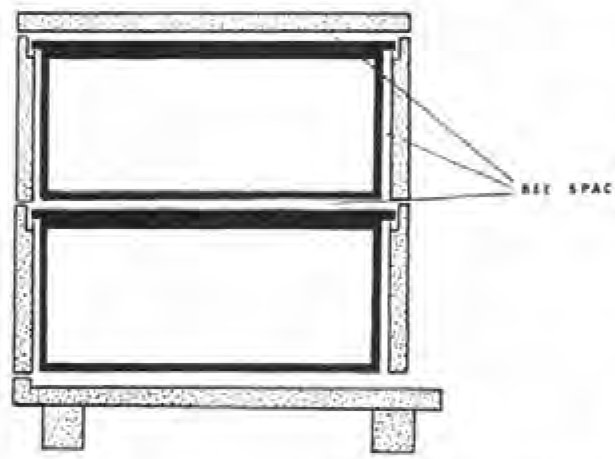


Figure 40.7b Langstroth's tiered hive (vertical cross-section) in the 2nd (1857) edition of his 1853 book. *Below*: vertical cross-section of a Langstroth hive at right angles to the other, showing 2 frames face on (Walton, 1975).

Figure 40.7a The Reverend L.L. Langstroth (date and photographer unknown).

ning, I could scarcely refrain from shouting out my 'Eureka' in the open streets.

Langstroth's 1853 book did not illustrate the hive, or give its dimensions. His 1852 patent (below) was not very specific about dimensions but offered an assembled hive for sale. The second edition of his book (1857) included the drawing reproduced in Figure 40.7b (left), and quoted dimensions which are not very different from those of hives now used: brood frame $17\frac{3}{8}$ x $9\frac{1}{8}$ inches (44.1 x 23.2 cm) externally, hive (single box) $18\frac{5}{16}$ x $14\frac{11}{16}$ x $9\frac{19}{32}$ inches (46.5 x 37.3 x 24.4 cm) high internally. Johansson and Johansson (1970b) wrote on the subject in detail and discussed a tradition that Langstroth's original brood box was a wooden case in which bottles of champagne had been sent from France; they concluded that this could have been true. Measurements I made in 1987 on cartons in which wines and champagne were transported within France also support the idea that a case for bottles of champagne (not wine) might have been used.

Langstroth's top-bars rested in a deeper rebate than others had done, leaving a bee-space above the frames. The bees did not build comb between frames in superimposed boxes, and there was no need to use a cheese wire when taking a box off. Also a board used as a cover over the top box was not attached to the frames by the bees, and could easily be lifted off.

As was customary in the USA at the time (Section 38.4), Langstroth obtained a patent for his hive, no. 9,300, on 5 October 1852. Its concluding paragraphs read:

What I claim as my invention, and desire to secure by Letters Patent is

1. The use of a shallow chamber substantially as described, in combination with a perforated cover for enlarging or diminishing at will the size and number of the spare honey receptacles.

2. The use of the movable frames A, A, Fig. 4 – or their equivalents – substantially as described – also their use in combination with the shallow chamber with or without my arrangement for spare honey receptacles.

3. A divider [upright division board] substantially as described in combination with a movable cover allowing the divider to be inserted from above between the ranges of comb.

4. The use of the double glass sides in a single frame substantially as and for the purposes set forth.

5. The construction of the trap for excluding moths and catching worms, so arranged as to increase or diminish at will the size of the entrance for bees, substantially in the manner and for the purposes set forth.

(signed) L.L. Langstroth

Johansson and Johansson (1967a) gave more information on the patent and various infringements of it, and Johansson (1995) reported on a reissue of the patent, no. 1,484 in 1863.

40.8 Annex: Rational movable-comb top-bar hives in development programmes

In the 1960s various attempts were made to improve the productivity of beekeeping in tropical Africa, where traditional hives were horizontal. Movable-frame hives were alien to local beekeeping tradition, and often proved unsuitable because of the precision needed in making them and their consequent high cost, also the precision needed in using them. In addition, tropical African bees were readily alerted to sting, and large numbers of them were likely to fly out as soon as a standard type of movable-frame hive was opened. Possibilities were therefore explored of adapting traditional top-bar hives (Chapter 39) to provide a rational substitute for traditional African hives (Chapter 28), which would be cheaper and simpler than movable-frame hives but would nevertheless enable beekeepers to obtain more control over their bees. In 1965 Papadopoulo in Rhodesia reported on keeping tropical African bees in a hive similar to the Greek one in Figure 39.3a.

Also in 1965, at the Hampshire College of Agriculture in England, C.J. Tredwell and Peter Paterson, a student from Kenya, built and used a hive on the same principle, but it was a shallow rectangular wooden box with sloping long sides (Tredwell, 1976); all the top-bars across the top had the same length and were interchangeable (Figure 40.8a). This hive was similar in some ways to J.A.'s 1683 hive (Figure 40.6a), but was fitted with top-bars at the correct bee-spacing instead of frames. In the 1965 hive, top-bars were made full width (35 mm), so that they fitted close against each other and no bees could fly out when the hive cover was removed; when one top-bar and its comb were lifted out, bees flew only from the narrow gap, and could be controlled by smoke. Townsend (1976) described the final successor to the 1965 hive, which became known as the Kenya Top-Bar (KTB) hive. Its width was chosen so that top-bars with their combs could be transferred

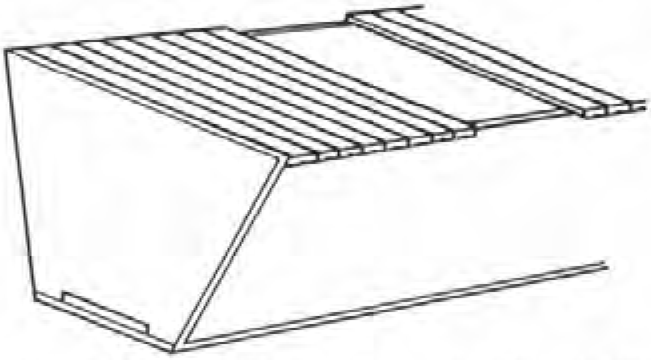


Figure 40.8a Tredwell-Paterson top-bar hive, England, 1965 (Tredwell, 1976). *left* Original sketch. *right* Hive in use, 1965 (photo: P.D. Paterson).

directly to a Langstroth hive. Crane (1990a) described a number of subsequent rectangular top-bar hives, which have been widely used in tropical countries. Some are made of very inexpensive materials, and the only precision measurement is the top-bar spacing.

Part VIII

DEVELOPMENT OF BEEKEEPING USING MOVABLE-FRAME HIVES

Chapters 41-45

41

Impact of Langstroth's Movable-Frame Hive on World Beekeeping

41.1 Introduction

Langstroth in North America was enabled to design his movable-frame hive for the honey bee *Apis mellifera* in 1851 because of improvements to traditional hives in Europe, and especially to hives devised on 'rational' principles in England between 1649 and 1850 (Chapter 40). Langstroth's hive of tiered wooden boxes was made from durable seasoned timber – then readily available – for use out-of-doors, and it was especially beneficial in areas that could give high honey yields. In 1853 Langstroth published his beekeeping book which described the hive, and beekeepers in the United States were ready to take advantage of it. They led the world in its use, and developed many important accessories for it (Chapter 43). Sections 41.62 and 41.72, respectively, discuss its modification and use for Asian hive bees *Apis cerana* and tropical African hive bees *A. mellifera*.

In the 1850s, as now, natural conditions differed in the various regions of the world: in climate, nectar and pollen sources, and native honey bees. Regions also differed in the effectiveness of their traditional beekeeping, and in their general level of prosperity, infrastructure and technological progress. Whenever movable-frame hives based on Langstroth's were introduced to a new country, there were different opinions as to the best size and shape for the hive boxes, and the number and dimensions of frames. In the USA and in some European countries, certain dimensions eventually became established as the national 'standard'; in countries where the frame hive was introduced subsequently, one or other of these standards was often adopted. The main types were: Langstroth's original pattern; Dadant and Dadant-Blatt in countries with French connections; British National in those with British affiliations; and Modified Dadant in many countries, for large-scale beekeeping (see Figure 41.3a).

Movable-frame beekeeping necessitated a much higher capital investment than traditional beekeeping, and in the early days many beekeepers found it difficult to afford – or even to get – the equipment described in Chapters 43 and 46. In most countries the new beekeeping was taken up primarily by people with adequate financial resources and those who were more educated. One outcome of the first introduction of movable-frame hives to a country was likely to be the formation of Beekeepers' Associations and the publication of beekeeping journals, both of which played an important part in disseminating and improving the new beekeeping (Chapter 42).

The use of movable-frame hives in itself enabled beekeepers to produce much more honey per hive, especially in good areas. It started in the period when machinery made woodworking more rapid and less expensive. At the same time, land and sea transport was becoming mechanized; honey was sold at increasing distances from its place of origin, and a 'world honey market' came into being. Honey produced in countries where yields per hive were high, and labour costs low, could be transported half way round the world to countries with lower yields and higher labour costs, and sold there more cheaply than home-produced honey (Section 46.44).

This Chapter follows the initiation and development of movable-frame beekeeping during its spread to different parts of the world. Tables 36.4A, 36.4B and 36.5A include confirmed and probable dates when movable-frame hives were introduced in countries of Asia, Africa and Europe; dates for some other countries are included in the text of Chapter 36.

41.2 The USA and Canada

The impact of movable-frame hives was felt first and foremost in the USA. Beekeepers experimented with frames that differed in size and shape, and with a variety of hives which they fitted with frames. More advanced methods of bee management were developed (Chapters 43 and 44), and it became possible and profitable for a beekeeper to operate many more hives than previously.

'Comb foundation' was first manufactured in 1857

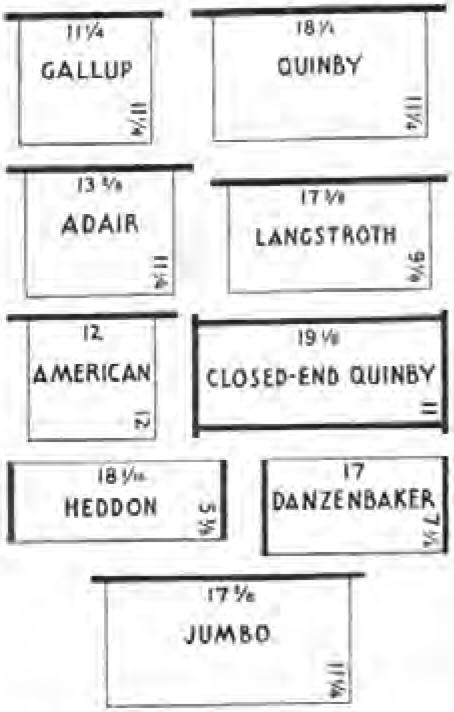


Figure 41.2a Dimensions of brood frames used in the USA (Root & Root, 1940). Jumbo is now known as Modified Dadant. Dimensions are in inches (1 inch = 25.4 mm).

(Section 43.2), and in the same year comb honey was also produced in small 'sections' (Section 43.1). Beekeepers producing section honey needed a small hive (which contained small frames); during the flow the bees became crowded and were forced to store honey in the sections. These beekeepers used a system led by James Heddon known as the contraction method, and it characterized one type of beekeeping during the period between 1876 and 1906.

Other beekeepers extracted honey from combs in movable-frame hives as they had done from fixed-comb hives, mostly by straining out the wax from crushed combs (Section 46.1). Then in 1864/65 the centrifugal honey extractor was invented in Europe (Section 46.22), and in 1869 or 1870 it was sold in the USA by H.O. Peabody in Boston. It made possible the efficient extraction of large quantities of liquid honey from the combs. The total amount of honey produced in a large hive with large frames was much greater than that from sections in a small hive. Moses Quinby (in 1866) was among the first to advocate a frame with a larger area, and Charles Dadant devised the (Dadant) hive with 11 Quinby frames in the brood box so that the queen could continually lay eggs up to her capacity (e.g. K.L. Pellett, 1927).

Hive boxes holding frames from which honey was harvested were called 'supers', because they were superimposed on a brood box; they had the same cross-section as the brood box but were often shallower. Any number could be added, and Figure 43.5a shows some extremely tall hives. Shallower boxes were used for several reasons: bees more readily started to work in a shallow super; when the box was full, bees could be driven out of it more easily; a full box weighed less and was easier to lift; honey could be extracted more rapidly from shallow frames. A full Langstroth shallow box weighed about 20 kg and a deep one 30 kg, and Dadant boxes were heavier still. Some beekeepers used deep boxes for honey because of the benefits of having only one standard hive box.

The fact that there were two styles of beekeeping, for sections and for 'extracted' honey, was partly responsible for the multiplicity of hives and frames. Also, some beekeepers believed that the brood box should be so deep that the brood could occupy a roughly spherical space, and in cold weather its temperature could be maintained by the smallest number of bees. Figure 41.2a shows eight of the frames that came into wide use in different areas of the USA in addition to Langstroth's. Quinby's and the Jumbo (later Modified Dadant) were the largest; Gallup, Adair and American were small but deep; Heddon's was the shallowest, but he used two boxes together as a 'divisible brood chamber'. A.I. Root's view in 1895 was that 'the Langstroth frame ... has obtained all but universal acceptance in the United States and Canada, and it may now be safely regarded as the standard. .... The eight-frame Langstroth hive is now generally conceded to be the best working size; and it is plenty large for general purposes.'

Pellett (1938), Root and Root (1940) and others described frame hives developed in the USA. The number of different ones may be judged by the fact that over 500 were patented during the twenty years from 1853 to 1873 (Leggett, 1874); in the latter part of the period patents were issued at a rate of nearly one a week. In 1915 C.C. Miller commented that, to individual US beekeepers, 'their own inventions and plans seem best to them: they would spend a dollar and a day's time to get up [an implement] of their own make, rather than spend 25 cents on a better one ready-made.'

In western Canada and parts of the USA west of Colorado, beekeeping was usually started with movable-frame hives, since honey bees did not reach these areas until after 1853 (Table 36.2B). The use of movable-frame hives gave rise to new possibilities in commercially profitable beekeeping, and also to some new problems. For instance certain areas had extensive summer honey flows, but it was difficult to

Figure 41.2b Apiaries in British Columbia, Canada. *top, in summer*: G.F. Pearcey's at Enderby in 1947, with 90 hives yielding more than 90 kg honey per hive. *right, in winter*: W.H. Turnbull's at Penticton in 1931, where 840 hives were overwintered together.

keep colonies alive through long cold winters. Some beekeepers wintered their hives in the more equable west coastal region (Figure 41.2b), and others wrapped each – or a block of four – in much insulating material (Figure 41.2c), or outer 'winter cases' were used. Still others built half-underground bee cellars such as Doolittle's (Figure 41.2d), which was very fully described in the 1895 publication. Doolittle lit his candle in the anteroom, passed through three further doors that separated off two air chambers, and finally entered the 'cave' where hives were closely packed along the sides. By the late 1900s, the necessary equipment became available to construct controlled-temperature buildings (Section 32.33). But before then, an alternative to overwintering became possible by the use of package bees (Section 44.32).

In western USA, California proved very productive for movable-frame beekeeping. The best known pioneer beekeeper was J.S. Harbison; another was M.H. Mendleson who had an apiary of 700 hives at Piru. In 1878 southern California alone produced over 3000 tonnes of honey. Pellett (1938) gave an account of the successes and failures, and Pickens (1975) published a bibliography. Williams (1975) described early movable-frame beekeeping in Oregon.

In Canada, movable-frame beekeeping must have existed in Manitoba by the 1860s. According to the *Carman Standard* in Winnipeg, hives of bees were then overwintered there in pits, and branches were laid over them as a protection against bears; the pits would later become filled with snow. The Red River Apiarists' Association was started in 1870. In 1879 Winnipeg had imported honey, but in 1883 F.A. Meyer of Portage la Prairie submitted at Brandon Fair 'a beautiful sample of strained honey which would gladden the heart of our enthusiastic apiarian Judge Walbridge' (King, 1996). B. Losee's report in 1885 *Canadian Bee Journal* (p. 135) suggests that he successfully wintered about 40 out of 50 colonies at Cobourg north of Lake Ontario. In 1886 F.W. Jones – a pioneer of Canadian beekeeping – reported from Quebec (p. 71) that the Langstroth hive was used, also another hive with a deeper brood box, and 'Bristol L.', with an outer case for winter in which chaff could be packed round the hive. On page 132 he

Figure 41.2c Langstroth hive prepared for winter, interior British Columbia, 1940s (photo: J. Corner). The tar paper wrapping covers an inner paper layer, and an empty top super is filled with insulating material. An upper entrance, ventilation, and facilities for feeding, are provided.

reported the loss of only 7% of his 151 colonies, wintering some in a Bristol L. hive out of doors, and others in a cellar. He said that apiculture had made 'wonderful strides in this province – in the townships especially'.

41.3 Europe

Europe was much more densely populated than North America, and beekeeping had been practised for many centuries; the number of hives per square kilometre was much higher than in other continents (Table 41.8A). There were many separate countries, with their own languages, and use of the movable-frame hive in a country often started after a description had been published in a language the beekeepers knew. Table 36.5A gives the earliest year found for movable-frame hives in a number of countries, including some not mentioned individually in the text.

In England T.W. Woodbury, a leading beekeeper who lived in Devon, made a movable-frame hive – in

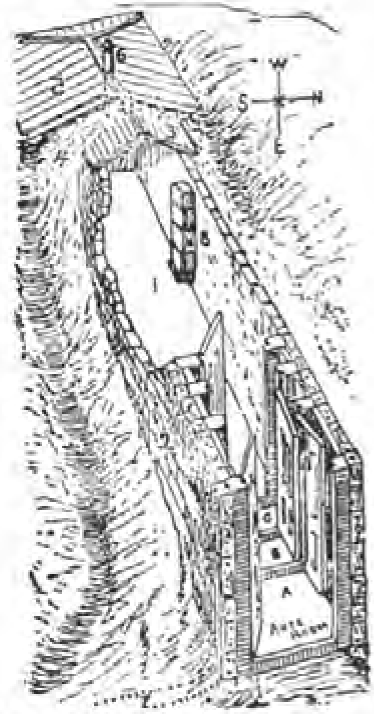


Figure 41.2d Doolittle's bee cellar, built in New York State in 1888 (A. I. Root, 1895). See text.

1860 according to Brown (1975) – and published concise instructions for its use in 1862.* He said that he believed Berlepsch in Germany (see below) to be the inventor of frame-hives. Woodbury mentioned in a footnote that Langstroth, 'an American apiarian, and author of an excellent work on the subject, also claims to have invented them about the same time'. Use of the hive spread through England, and to Wales and Scotland. In 1874 it reached Ireland, where a quarter of the hives had movable frames by 1885 and three-quarters by 1916 (Watson, 1981, 1995). Later, British standards were based on Woodbury's hive and his frame (14 x $8\frac{1}{4}$ inches, 35.6 x 21.0 cm); both were smaller than Langstroth's. They were manufactured by George Neighbour and Sons from 1862, and Alfred Neighbour (one of the sons) illustrated them in his 1865 book. Brown (1975) gave many details of Woodbury's life and activities.

T.W. Cowan, the Chairman of the British Bee-Keepers' Association from 1875 to 1926, described various hives in his 1881 book. His own hive was not very different in size from Woodbury's, but had an outer wooden casing, and the space between this and the hive was filled with chaff for winter. Double-

*In the 1950s Graham Burtt saw a copy of Langstroth's book in a farm sale, with an inscription showing that Langstroth had presented it to Woodbury in 1862; Burtt purchased it and gave it to the IBRA Library.

walled hives came into common use in some northern parts of Europe; one of the best known, referred to as the WBC, was designed in England in 1890 by W.B. Carr.

Charles Dadant was born in Haute-Marne in France and emigrated to the USA in 1863. He wrote about his movable-frame hive (p. 428) in French journals, which resulted in its use in France by 1869, and in 1874 he published a beekeeping book in French. Johann Blatt, an active leader of modern Swiss beekeeping between 1862 and 1884 (Sooder, 1952), produced a variant of the Dadant hive known as Dadant-Blatt, with 12 frames of the Quinby depth and Langstroth length. This hive became common in French-speaking areas of Switzerland and Belgium, and also in Spain, Italy, the Netherlands, Greece, Russia and Latvia. The Modified Dadant hive, produced in the USA in 1920, had 11 of the same frames; an example is shown in Figure 41.3a. Various other types of tiered hive were developed in Norway, Sweden, Denmark, Finland, Poland, Yugoslavia and probably elsewhere; see Mátyás (1932).

The 1881 book by Cowan referred to above was *The British bee-keeper's guide book*, which was republished in many editions, the last (25th) in 1924. It was widely influential in Europe through its many translations: Danish and Bulgarian (1887), Spanish (1888), French and German (1889), Dutch (1903).

Figure 41.3a Brother Adam among his Dadant-type hives, Buckfast Abbey, Devon, England, 1930s? (photo: R.V. Roberts).

In the area where German was known and read – including Germany, Austria and parts of Switzerland, Czechoslovakia, Hungary and Yugoslavia – beekeepers followed Dzierzon in using back-opening hives. Dzierzon's own hive (1848) had been successful with top-bars (Section 40.6). In 1853 Berlepsch added bottom and end-bars to Dzierzon's top-bar to make a frame; he understood the bee space, achieving a movable-frame hive about a year after Langstroth did so (Ruttner, 1981); he described it in his 1860 book. During 1853 Berlepsch and Dzierzon carried on a correspondence in the *Eichstädter (Nördlinger) Bienenzeitung*. Berlepsch, like Dzierzon, knew about Prokopovich's 1814 hive but probably not about Langstroth's. Gravenhorst (1873) introduced a different type of frame hive which remained in use for many years. It was made of coiled straw like a skep, but had a rectangular cross-section. Frames were inserted from below and hooked inside the roof; both frames and hive had a curved top.

Dzierzon's 1861 book, also published in English in 1882, described the use of properly spaced and distanced frames in his back-opening hive, and Figure 41.3b shows surviving hives of this type. (His first frames had been, like Prokopovich's, too close to the side walls of the hive, and the bees filled in the narrow gaps.) Dzierzon made rectangular hives of many shapes and sizes, but all had top-bars of the

Figure 41.3b Early back-opening hives fitted with frames (Fördererkreis der naturwisswenschaftlichen Museen Berlins). *From left* Log hive (with bars only), Upper Silesia; board hives: Upper Silesia, Baden, SW Germany; Kuntzsch hive, Berlin.

same length, so that he could move the bars from one hive to another. He seemed to prefer top-bars, 'which allow of the removal of every comb.... The bees fix their combs not only at the top, but also in different places at the sides, which necessitates our loosening every comb we wish to remove. This can be done easily and quickly with a very thin common knife, especially if it be heated a little before the fire.'

Ruttner (1981) pointed out that no good explanation has been found for the prolonged dichotomy between the use of movable-frames in back-opening hives – often in a bee house (Figure 32.3c) in German-speaking parts of Europe – and in top-opening hives out of doors in the rest of the continent and of the world. Was it perhaps partly a reverence for Dzierzon, who had a very strong personality? Or an attachment to bee houses, which preceded movable-frame hives? In German-speaking areas the use of top-opening hives lagged a full century behind their use elsewhere, and most hives were still back-opening in the 1980s (Hüsing & Nitschmann, 1987).

In Russia, where Prokopovich developed back-opening frame hives from 1814, the use of top-opening movable-frame hives was not similarly delayed. There, wax foundation was used in Prokopovich's frames in 1857, and the centrifugal honey extractor was introduced in 1865 (Galton, 1971). A description of Langstroth's hive was translated into Russian in 1892, and of Dadant's in 1901. Bilash and Krivtzov (1995) traced the expansion of modern beekeeping in Russia: by 1910 18% of 6 million hives had movable frames; by 1924, 55% of 5 million; and by 1938, 100% of 9 million.

In Spain the first movable-frame hives were used in 1885, and the first journal *El colmenero español* was started in 1892 (Gómez Pajuelo, 1993). Begnescu (1926) published a detailed study of hives used in Romania between 1860 and 1916, with distribution maps. In 1926 Romania had at least a million hives, a considerable proportion of them Dadant and other types with movable frames.

Mátyás (1932) published results of a detailed enquiry into hives then used in over twenty European countries. In many parts of Europe bee forage was less abundant than in North America, so less brood was reared, and the size chosen for the brood box of many early hives was smaller. The honey yield per hive was also lower, but honey production was not the only incentive to keep bees; many people enjoyed having them in their gardens, watching them and learning about them. There was also a difference between the attitude of beekeepers in the two continents towards designing hives. In the USA a beekeeper tended to patent a hive he designed (Section 41.2). In Europe either the inventor of a hive or a manufacturer might make it for sale, and a few other beekeepers were then converted to it, so hive types proliferated, especially in Germany, where Mátyás listed 21 sizes of brood frame in 1932, and hives might be made to accommodate different numbers of any one frame. I remember visiting Hamman's hive factory in Hassloch in 1951, and seeing sheets of comb foundation stocked in several dozen sizes. In France, dimensions of 18 different hives were listed in the 1970s.

41.4 The rest of the Americas

By the 1860s, beekeepers using honey bees in the Americas outside the USA and Canada got to know about the movable-frame hive through correspondence and personal visits, and through beekeeping journals (Chapter 42). They adapted the hive to suit local conditions and their own limitations, but the whole region was less advanced technologically. Few beekeepers were able to invest capital in the equipment needed for a large-scale enterprise, although sometimes this was made possible by foreign investment, as in Mexico. Almost all the regions were tropical or subtropical, so bees could fly during a much longer season. Certain regions gave long honey flows, and honey yields were considerably higher than farther north. In Argentina and Mexico honey production was developed to such an extent that each of these countries was the world's largest exporter of honey for a period after 1960 (Section 46.44).

41.41 Mainland America from Mexico to Panama

Details of introductions of movable-frame hives into this region are scarce, but Kent (1979) summarized much information on subsequent beekeeping with them. The first movable-frame hives probably arrived in Costa Rica about 1890. In 1893 the Mexican government distributed a questionnaire on beekeeping, and replies show that European honey bees – described as Castillan bees from Havana – were then more important than stingless bees (Brand, 1988). The use of movable-frame hives led to substantial honey exports from the 1930s onwards. Exports started to be of world importance during the 1940s when two Germans, A. Wulfrath and Dr J.J. Speck, established an enterprise south of Mexico City, Miel Carlota. Within twenty years (Figure 41.4a) its operations had expanded to include 50,000 hives (Willson, 1955, 1975). By 1965 Mexican honey ex-

Figure 41.4a Miel Carlota crew at work, Morelos province, Mexico, 1957 (photo: E. Crane)

ports had increased to 15,000 tonnes, and they reached 18,000 tonnes a few years later. In the Yucatan peninsula (Figure 30.1a) movable-frame beekeeping may have been started around 1900, and 140 tonnes of honey were produced in 1945. Because of difficulty of access, apiary sites were limited to clearings made in the jungle, adjacent to one of the few roads. In 1957 I saw many apiaries of 50 hives near a road, only 1 km apart, and these gave an annual average yield of 150 kg per hive. The hives were then owned by wealthy town dwellers and operated by Maya employees.

In Guatemala the first professional beekeeper arrived from Germany, with his bees, in 1908, and in the 1920s beekeeping was taught in many agricultural schools (Elmenhorst, 1952). In several countries, for instance Nicaragua, movable-frame beekeeping was probably introduced by German coffee producers. Costa Rica had been a net honey importer, but in 1908 the industrial census included beekeeping in 19 apiaries, and by 1929 there were 586; the hives probably had movable frames. Movable-frame beekeeping was recorded in 1957 for Belize, and in the 1960s for El Salvador and Honduras, but it may have been introduced earlier.

The speed of the changeover to movable-frame hives varied from country to country. By the 1960s, almost all hives in Belize, Costa Rica, Nicaragua and Panama had movable frames, and in 1980 80% of those in Guatemala, but El Salvador and Honduras were somewhat slower to change. Fixed-comb hives survived longest in backward and poor areas of all countries. In Mexico in the early 1950s, they still predominated in the north, but in the centre and near the Pacific coast 85-87% of hives had movable frames, and in the eastern Gulf region almost all of them (Kent, 1979).

Table 36.2A gives dates of the arrival of 'Africanized bees' after 1956, and Section 36.63 refers to the spread of the bees throughout the region.

41.42 Caribbean and neighbouring islands

In many islands, dark north European bees were introduced first and 'yellow' Italians later (Table 36.2C). Beekeepers operated mainly in the cultivated coastal areas, and even after they had used Italians for many years, dark bees still lived wild in uncultivated central hills.

The following facts exemplify special beekeeping developments and conditions in a few of the islands. In 1867 Villalon published a 475-page beekeeping manual for Cuba, and nearly 20% of the hives had movable frames in 1904. The new hives may have been in Bermuda by 1875, when the giant toad (*Bufo marinus*) was introduced to control cockroaches; it preyed on bees, as did the kiskadee (*Pitangus sulphuratsus*), a bird introduced in 1956/57 to control lizards (Hilburn, 1989). In Jamaica the new hives were used by 1886, and one beekeeper had 600 by 1902; see Phillips (1951). In many other islands, including the Cayman about 1885, nests of bees were collected to populate hives. In 1901 a bee expert was appointed in Barbados. But many islands were without movable-frame hives until after 1900. Puerto Rico exported 2 tonnes of beeswax in 1897, probably from fixed-comb hives, and when the USA took possession of the island in 1898 after the Spanish-American War, beekeeping was reported as 'not developed'; see Phillips (1914). The first European bees introduced to Curaçao in 1915 failed 'because the bees flew away due to strong trade winds', but 1920 imports did better. Hurricanes have always been a great hazard to beekeeping in the islands; among the most recent that did much damage were Hurricane Allen in St Lucia in 1980, Emily in Bermuda in 1987, and Hugo in St Kitts and Nevis in 1990.

41.43 South America

Section 36.25 describes the introduction of European honey bees to South America from 1839 onwards, and their subsequent transport to some of the inland areas. In many parts the bees produced much honey; for instance according to Nicolau Joaquin Moreira in 1878, the first colonies brought to Brazil in 1839 produced 10-18 bottles of honey there although they

had produced only 6-8 in Portugal (Nogueira-Neto, 1967). Honey bees did not reach most countries until the 1850s or later, after movable-frame hives were known. One feature of the development of movable-frame beekeeping in South America was the impetus given by waves of immigrants from European countries who were already familiar with it. For instance Germans pioneered the expansion of beekeeping in Paraguay and southern Brazil at the start of the 1900s; Ukrainians were active in Brazil between 1895 and 1900. In Uruguay where movable-frame hives were used from about 1879, many Russian immigrants arrived after 1900, and Russian-type hives were still in use when Toscano wrote in 1979. A 1902 report on Brazil by Fougères from France suggests that he taught some beekeepers there, and in Bolivia fruit growers were active in developing beekeeping. The ten-frame Langstroth hive was generally adopted in South America, but German types were also used and, in a few places, the deeper Dadant hive.

Chile exported honey (about 1000 tonnes) in 1885, and Paraguay in the 1920s. Between 1914 and 1938 Chile also exported beeswax (Section 46.82), suggesting that many fixed-comb hives were still used. Fougères (1902) reported that in French Guiana most honey was harvested either from natural nests or from hives of stingless bees, but there were apiaries of modern hives, and in Cayenne Mme Cablat's forty hives gave a colony average of about 40 kg of honey a year. Paraguay exported honey from 1921 to 1928, but beekeeping in Venezuela did not become 'intensified' until about 1939.

The book written by Candidado de Jesús Branco in Minas Gerais, Brazil (2nd ed. 1859), may have been the earliest beekeeping book in South or Central America. Emilio Schenk in Brazil, one of the leaders of modern beekeeping in South America who started to promote German methods of movable-frame beekeeping in 1896, published a book in German (1900), also in Portuguese as *O apicultor brasileiro* (1910). Both versions went into several editions, and the book was still used in Paraguay in 1954.

In South America not many decades elapsed between the start of hive beekeeping with *Apis mellifera* and the advent of movable-frame hives (Section 31.1). But the use of fixed-comb hives – usually wooden boxes – continued, and even after 1950 the percentage of movable-frame hives was generally lower than in Central America. Some examples are:

1956	Colombia		63%
1956	Paraguay		13%
1957	Uruguay		67%
1965	Argentina		c. 100%
1971	Chile		28%
1989	Chile		40%
1976	Venezuela		few
1986	Peru: coastal plain		40%
	Andes:		
		low jungle	74%
		highlands	82%
		high jungle	100%

In Huancayo, Peru, satisfactory movable-frame hives were made of mud and straw, or cement, which were not damaged by termites (Corner, 1995).

Africanized bees spread throughout most of South America after 1956 (Table 36.2D). Section 41.72 discusses the difficulties in using tropical African bees in movable-frame hives. One is that the bees tend to fly off the comb as soon as the hive is opened, and Langstroth's tiered hive was designed for bees that remain on their combs. It is interesting to speculate what type of hive with movable frames – or movable combs – would have become the prototype if its inventor had worked with tropical African bees or their descendants, instead of with European bees.

41.5 Oceania

41.51 Australia

European honey bees were introduced into all the Australian states – then still colonies of Britain – between the 1820s and 1860s. Each Australian state was still more or less a separate unit when movable-frame hives were first used, and the whole country was relatively isolated from North America and Europe where most beekeeping advances were being made. In the late 1800s comb foundation, queen excluders, bee escapes and centrifugal honey extractors were produced in the northern hemisphere, but it took a long time to import new appliances to Australia. Langstroth hives were commonly used.

An important asset to Australian beekeeping was the number of *Eucalyptus* species which flowered one after another, and each could give a substantial honey flow. Beekeepers obtained high yields by moving bees to a succession of flows, having first learned to identify the productive species and to predict their date of flowering from observations on the flower buds. Books were published with botanical descriptions and honey and pollen evaluations of the

different species, starting with Rayment (1916) and Blakely (1934), also Beuhne (1923) for Victoria, and Goodacre (1938) for NSW. Most Australian honeys were darker and more strongly flavoured than those preferred in temperate zones, and fetched relatively low prices on the export market.

Beekeepers' Associations and the first beekeeping journals were started in the 1880s (Section 42.7). The first beekeeping book for the region was Hopkins's *The illustrated Australasian bee manual* (1886), which incorporated *The illustrated New Zealand bee manual* of 1881. In 1916 Tarlton Rayment published *Money in bees in Australasia*. Sources of information on early beekeeping include: Morgan (1955/58) and Barrett (1995) who gave details for all Australia; Morgan especially for New South Wales; Roff (1983) and Weatherhead (1986) for Queensland; Coleman (1956) for Western Australia.

Honey yields varied greatly from year to year. Barrett (1995) gave production and export figures for the years 1891 to 1895. The following list for 1976/77 may be helpful when reading below of early honey yields in individual states (1 kg = 2.2 pounds).

	Mean yield per productive hive (kg)	*Total production of state (tonnes)*
Western Australia	86	3143
Tasmania	58	553
Queensland	42	1637
NSW	41	5077
South Australia	37	2787
Victoria	30	1713

Queensland

This was the first state to develop movable-frame beekeeping. James Carroll introduced Woodbury's movable-frame hive from England about 1870, and placed bell jars on top. In December 1873 he had 87 colonies; by March 1874 he expected to increase them by swarms to 400, and to extract 6000 pounds of honey for sale at 9d. per pound.* About 1874 Carroll imported a honey extractor, and Angus Mackay used his knowledge of equipment in a sugar factory to modify it to run at 200 rpm. (In 1865 Hruschka got his original idea for centrifuging honey combs from equipment in a sugar factory near Venice, Section 46.22.) In 1875 Carroll published *My little bee book* with 27 pages, which was revised as the *Queensland bee book* in 1891. But the wax moth started to infest colonies between 1875 and 1880, and in 1883 Carroll reported that 'apiculture in this colony has sunk to a very low condition indeed ... only a very few individuals ... managed to save a few stocks amidst the general devastation' (Weatherhead, 1986).

One of the first professional queen breeders was Charles Fullwood who imported five Italian queens (*A. m. ligustica*) from Italy to Brisbane by 1880. H.L. Jones started keeping bees in gin cases in the same year, and was probably using movable-frame hives by 1884 when he had a 'beautiful new Bingham [uncapping] knife'. In 1886 the Queensland Beekeepers' Association was formed.

Selling Australian honey was often a problem, and Queensland was then producing a surplus. Bulk honey was offered for sale at between 4d. and 5d. per pound in 1887, and at 3d. in 1892 (Weatherhead, 1986); in 1890 Queensland had exported 50 tonnes to Britain. But in 1900 honey crops were falling, and the Association had ceased to exist; the Federal Government later imposed a duty of 1½d. per pound on all imported honey.

In 1904 H.L. Jones was manufacturing hives, comb foundation and extractors, and by 1905 use of the Langstroth hive was fairly universal; escape boards were inserted for removing bees from supers, and 'two boys were able to extract an average of 1200 pounds [0.55 tonnes] of honey in a day, using a 4-frame Cowan extractor'.

South Australia

There was much beekeeping activity here in the 1880s, including the establishment of Kangaroo island as a bee breeding station in 1883 (Section 36.51). In 1887 the SA Parliament passed a Foul Brood Act to reduce the spread of the disease (caused by *Bacillus larvae*), although many beekeepers objected to the Act and some regarded foul brood as 'only another name for starvation'.

The Beekeepers' Association staged an exhibit of honey, beeswax and beekeeping appliances at the Royal Show in 1886.

Victoria

Movable-frame hives were first mentioned in the 1880s. A Victoria Beekeepers' Association was founded in 1884, and the first Australian bee journal was published in Melbourne from 1885 (Section 42.7). In the same year H. Naveau in Hamilton advertised Italian bees and queens, comb foundation and Langstroth hives; in Melbourne zinc queen excluders and a form of Clark smoker were made. Honey yields were high, and in 1886 honey from Victoria was exhibited at the Indian and Colonial Exhibition in London. A one-pound section then

*1d. = 2.4p; 100p = £1 sterling.

Figure 41.5a 'An old bee farm', painted by Clara Southern, c. 1900 (by courtesy of the National Gallery of Victoria).

fetched 1s. 3d. to 1s. 6d., extracted honey 6d. to 9d. per pound, and strained honey from natural nests or box hives 3d. In 1888 a company managed by L.L. Chambers sold 3000 hives in 6 months, mostly in Victoria, and section boxes were also in great demand. To Chambers, the 8-frame hive 'was a handy size and would give satisfaction'.

Figure 41.5a shows an apiary about 1900.

New South Wales

A Mr Garrett had a home-made hive based on Langstroth's (Rayment, 1922), perhaps in the 1870s. In the early 1880s the Italian Bee Culture Farm was established at Parramatta near Sydney, and in 1888 – as the Italian Bee Company – it won all the first prizes at the Centennial Agricultural Exhibition in Sydney. In 1894 a Honey Co-operative was formed, the first in Australia. Pender Bros at Maitland on the Hunter River manufactured hives, and by 1922 American Langstroth and Heddon hives 'were supreme'; Figure 41.5b shows a later migratory apiary at a stand of *Eucalyptus*. Articles by Morgan (1955/58) give much further information.

Western Australia

Little is known about the start of beekeeping with movable-frame hives. In 1873 William Jones at Guildford had 'a very large bee farm', the only one at the time. In 1881, 16 cases of Swan River honey were sold in London. In the 1880s wax moths killed many colonies of British black bees, and Italians were introduced – presumably from eastern states. Commercial beekeeping started to make headway in the 1890s, and in 1896 C. and A. Smith – who arrived from South Australia with their bees – were the first migratory beekeepers in the state, using horse-drawn vehicles. In 1903 Western Australia had 3100 colonies which produced 42 tonnes of honey.

Tasmania

In 1885 beekeeping was still done largely with box hives, which gave good yields, and movable-frame beekeeping had not gained much ground, but in the late 1880s there were already commercial beekeepers. Later, competition from honey bees nesting in trees was so great that it reduced hive yields (Gilbert, 1906).

41.52 New Zealand

Many of the comments on early movable-frame beekeeping in Australia apply also to New Zealand, but there were no eucalypts, and introduced white clover gave light-coloured honeys acceptable to consumers in Britain.

Isaac Hopkins was the main leader in the new beekeeping, and the prime mover in creating a national beekeeping industry. He went to New Zealand from England as a young man, and started to keep bees in box hives (gin cases) in 1874. During the next three years he experimented with Nutt, Stewarton, Berlepsch and Woodbury hives. In 1877 he obtained from London a copy of Langstroth's 1853 book, and

Figure 41.5b Migratory apiary at a stand of *Eucalyptus*, New South Wales, 1967 (photo: E. Crane).

imported from the USA a Root comb-foundation mill and also the working parts of a honey extractor. By 1879 the whole of his apiary of fifty hives 'was established on modern lines'. He imported two colonies of Italian bees from California by 1881, and others direct from Italy in 1883.

Hopkins published *The illustrated New Zealand bee manual* in 1881; this sold out quickly and there was a second edition in 1882. He wrote many beekeeping articles and started the first beekeeping journal in New Zealand. In 1905 he was appointed the first Government Apiarist; in 1906 the first Apiaries Act was passed (Winter, 1954), which outlawed box hives. Meanwhile New Zealand was exporting honey, for instance 89 tonnes in 1891 and 24 tonnes in 1895 (Barrett, 1995).

New Zealand beekeeping is well documented. Bee World (1922) published a biography of Hopkins, Baines (1923) summarized beekeeping in New Zealand up to 1923, and Winter (1954) described the beginnings of beekeeping legislation there. Reid *et al.* published a full bibliography in 1988.

41.53 Pacific islands

It is convenient to deal here with the island of New Guinea, which lies north of Queensland. European honey bees (mostly Italian) were introduced in movable-frame hives from Queensland in 1948. Two colonies were taken to the highlands, and within two years they had increased by swarming to thirty; in general, colonies in hives or nesting in trees did well there but did not thrive elsewhere. Michener (1963) and Kidd (1979) gave more information for Papua New Guinea, but none was found for Irian Jaya.

Islands in the Pacific Ocean were formed from volcanoes or coral atolls, so their plant and animal life developed from whatever flew, swam or drifted to them from elsewhere; they had no native honey bees. Honey bees, and movable-frame hives, were introduced in and after 1857 (Section 36.33). Many islands had a very good climate and flora for beekeeping, but their small size, and the distance over which imports or exports had to travel, imposed a constraint on any beekeeping industry. Wood for hives had to be imported to many islands, and in use it was much damaged by dry rot, termites and tropical storms. In the North Mariana Islands 10-frame Langstroth hives of cement, sand and wire mesh lasted better (Hobson, 1983).

Walsh (1968) and Walton (1976) gave details about a number of islands, and Crane (1978a, Part 7) listed sources of information about beekeeping on all islands where it was known to exist. With their benign climate and their isolation, Pacific islands were promising candidates for rearing and breeding queen honey bees, and such enterprises were established in Hawaii, Raratonga in the Cook Islands (Simpson, 1969) and Tonga (Walton, 1976). The four islands referred to below illustrate some of the peculiar difficulties and achievements of Pacific island beekeepers.

Hawaii

This was the first Pacific island group to get honey bees, from the USA in 1857 (Section 36.33). The US Department of Agriculture carried out various studies between 1905 and 1908 (Phillips, 1909). American foul brood disease was present by about 1928, and beekeeping declined; colonies were left unattended and many died. Then in 1949 it was found that the surviving bees had developed a resistance to the disease (Eckert, 1950). In 1976 a queen rearing enterprise was started on Hawaii Island, which expanded its annual production to 143,000 queens a year by 1993: the island's isolation and freedom from bee diseases and parasites became increasingly valuable assets.

In 1838 Father Alexis Bachelor, a Catholic missionary, had introduced kiawe (*Prosopis pallida*) from South America to Hawaii, and early planters distributed seeds from the original tree throughout the islands. It became a most prolific honey source, especially on the island of Molokai where hives of bees were taken in 1901 (Esbenshade, 1980). When I saw the honey flow in August 1979 there were about a thousand hives on the island, which would yield 120-150 tonnes of honey.

French overseas territories

The French promoted beekeeping in these islands, as in their other colonial possessions. Fougères reported on several islands in 1902, including the price of honey and beeswax, and possibilities for their production and export. In French Polynesia, Tahiti had 1000 hives, mostly Langstroth, and in New Caledonia there were three apiaries (60-80 hives) in Nouméa, where Dadant hives 'for sections' were used; however, Vallette reported in 1922 that frame hives were almost unknown. Italian bees had been imported from Australia.

Figure 41.5c Inspection of a colony in a Langstroth hive on Niue, 1970s (photo: G.M. Walton).

Niue

Colonies taken in 1952 died out, but others in 1963 and 1967 succeeded (Mackisack, 1968). By 1976 a single enterprise ran 1200 hives in 40 apiaries (Figure 41.5c), giving an average annual honey yield of 50 kg. To Walton (1976), Niue was 'probably the most intensively bee-farmed of the self-governing countries of the world'. The honey was marketed through New Zealand channels.

Easter Island

Bees taken in 1930 had died out by 1981 (Section 31.5) and Gerardo Velasco then brought four small colonies from Chile, which produced 70 kg of honey per hive. After other introductions during the 1980s, there were 72 colonies in Hanga Roa, but the colony

yield had dropped to 20 kg (Velasco, 1989), probably because of overstocking (the island was by then deforested). This led to a plan for producing queens rather than honey, which was supported by Szabo (1987).

41.6 Asia

41.61 From the Mediterranean coast to Persia

The native hive bee in this region is *Apis mellifera*; ecotypes in some countries – for instance Turkey – proved very well suited to movable-frame beekeeping, but those in coastal areas to the south did not.

The Langstroth hive was adopted as standard in most of the region. By the late 1980s, about two-thirds of the hives in Persia (Iran), the largest country, had movable frames, and the same was true in Turkey – with 2½ million hives – and also in Syria with 150,000. Since the formation of Israel in 1948, the productivity of its beekeeping with movable-frame hives has been consistently increased, partly by replacing unproductive local bees by Italians (end of Section 36.51). At the other extreme, only 17% of Jordan's 44,000 hives are modern ones.

The United Arab Emirates probably had no traditional beekeeping, and movable-frame beekeeping started late, in Abu Dhabi with Carniolan bees from Egypt in 1978, and in Dubai – and probably Fujairah and Ras al Khaimah – with Italian bees in 1985.

41.62 Asia east of the Urals and Persia

Except in Siberia and Mongolia, hive beekeeping in this large region was first developed with native *Apis cerana*, using traditional fixed-comb hives (Chapter 29) and in one area movable-comb hives (Section 39.52). Movable-frame hives were introduced in different areas between the 1870s and the 1980s, often at the same time as European *A. mellifera* (Table 36.4A) which could give high honey yields. Crane (1989a) gave some details and references for individual countries. Apart from Japan and China, movable-frame beekeeping with either species probably started earliest in countries where a colonial power encouraged the development of agriculture. The list below gives an idea of the sequence.

1870s: Japan, Russia (Siberia), Sri Lanka
1880s: India, Indonesia, Pakistan
1890s: China
1900s: Manchuria, Russia (Far East), Vietnam
1910s: Korea, Taiwan
1920s: Kashmir in India, Singapore
1930s: Bangladesh, Malaysia
1950s: Afghanistan, Cambodia, Mongolia, Thailand
1970s: Nepal, Philippines
1980s: Bhutan, Myanmar.

Section 36.41 describes the extension of the range of *A. mellifera* across Siberia. By 1900 apiaries were established as far east as the Ob and Yenisei rivers. Ukrainian *A. mellifera* was taken to Siberia east of Lake Baikal in 1901, and long single-box hives with Dadant-Blatt frames were used (Kotzin, 1931). In Mongolia there were no honey bees until *A. mellifera* was taken in 1959 (Ryauzov, 1980); by 1978 there were 1900 colonies.

In China, although *A. cerana* was native, beekeeping in movable-frame hives seems to have started first with dark Russian *A. mellifera* in the north-east in 1896, and then in Xinjiang in 1900 after the Russians invaded it (Chen Yaochin, 1993). Hanson reported on beekeeping in Manchuria in 1923. Faraut (1909a) described his beekeeping with *A. mellifera* in Vietnam. Cadapan (1984) gave details for the Philippines, from 1913.

The movable-frame hive introduced to Asian countries had been designed for *A. mellifera*, and its dimensions matched that bee. It was not successful with the smaller *A. cerana* in most parts of Asia, until the size and type of hives and frames suitable for the ecotype native there had been established. Blandford (1923/24) described beekeeping at Kulung, 800 km up the Yangtse River in China, and his frustrating attempts to keep *A. cerana* in Langstroth hives.

In the Malay peninsula the first recorded use of frame hives was in the 1930s by Lim Choo Kiat, a Straits-born Chinese in Singapore. According to *The Straits Times* he had 22 colonies, the progeny of Italian *A. mellifera* imported from Australia, and obtained nearly 70 kg honey per hive (Bee World, 1939). In the 1950s one Chinese beekeeper was said to have got 40 kg per hive, and in 1988 another living near Muar in Johore told me that he had started in 1985, now had 250 hives, and got 30 kg honey per hive. The first frame hives made for *A. cerana* had dimensions for *A. mellifera* and were unsatisfactory (MAHA Magazine, 1936). However, a successful research and development programme was started in 1987, and Figure 41.6a shows an example of the hives used.

Atwal and Goyal (1973) described their first beekeeping with introduced *A. mellifera* in Pakistan and India, and Goyal (1974) discussed the ways in which hive beekeeping with *A. mellifera* and *A. cerana* interacted.

Figure 41.6a Movable-frame hive of *A. cerana* with 2 shallow frames lifted out, Kuala Lumpur, Malaysia, 1988 (photo: E. Crane)

India has a wide range of altitudes and of latitudes, and there is a great variation in the body size of *A. cerana*, which is largest in the north and smallest in the south. The south had almost no traditional beekeeping, but in the early 1900s Father Newton in Travancore introduced a movable-frame hive for *A. cerana* (Bhupen Apiaries, 1939; Singh, 1962). Use of the Newton hive continued widely in the south and some other parts of India, and also in Nepal after beekeepers introduced movable frames there. The Khadi and Village Industries Board (later Commission) was active from 1953; see its 1958 book. It promoted movable-frame beekeeping with *A. cerana* throughout India, which Thakar described in 1976. The Indian Standards Institution (1970) published standards for *A. cerana* hives in three different areas, with brood box volumes of 20.0, 13.8 and 12.8 litres. The volume of a 10-frame Langstroth brood box is 40 litres.

In the 1920s movable-frame hives were introduced into Indian Kashmir, probably by Neve (1931). This high region is of special interest because its *A. cerana* bees have a large enough body size, and build large enough colonies, to be kept in a standard Langstroth hive fitted with *A. mellifera* comb foundation. Members of the Shah family in Srinagar published accounts of their operations (e.g. 1975; see also Neve, 1931); Figure 41.6b shows their migratory beekeeping. In Sri Lanka, Jayatillate wrote about movable-frame beekeeping with *A. cerana* in 1881, but only 40% of hives had movable frames by 1984. In some more tropical regions where traditional hive beekeeping had hardly penetrated (end of Section 29.62), movable-frame beekeeping did not start much before the 1950s.

In Indonesia, Ochse (1932) described several hives for *A. cerana*, and Patra and Suwanda (1988) recounted the history of *A. cerana* beekeeping since its collapse during the Second World War.

In Nepal and Thailand, progress benefited from the interest of the King or another member of the royal family.

Faraut (1909a) reported from Annam (north Vietnam) that the two hives of French bees (*A. mellifera*) he had imported were full and prospering; he proposed to use one to make an artificial swarm to put into a Dadant hive that had just arrived from France. He had acquired seven swarms of Annam *A. cerana*, and had united two pairs, hiving the colonies on movable frames; they were doing well in spite of attacks by ants and wax moths. Faraut was also identifying plants worked by the bees from a study of the pollen grains in the loads carried back to the hives.

In some countries, for instance Korea, China, Vietnam and Thailand, many beekeepers adopted a single-box system with movable frames, for *A. cerana* or for *A. mellifera*, which involved minimal capital outlay. At frequent intervals during a flow, a few frames were removed, centrifuged and immediately replaced; many of these frames contained uncapped honey with too high a water content for safe storage, and also brood. Verma (1989) suggested that this

Figure 41.6b Langstroth hives being taken off a truck, to be carried as head loads further into the hills, Kashmir, India (F.A. Shah, 1975).

system originated among peoples who ate brood as well as the honey (Section 51.6).

Table 41.8A shows that between 1971 and 1984 the total number of hives in Asia was more than doubled, and most of this increase probably represented movable-frame hives of *A. mellifera*. When the People's Republic of China was founded in 1949, there were about 100,000 hives of *A. mellifera*. By 1988 these had been increased to about 6 million, more than any other country except the USSR; there were also about 1 million hives of *A. cerana*.

41.7 Africa

41.71 The Mediterranean north

Beekeepers in countries of North Africa had contact with developments in Europe, and their bees could be managed in a fairly similar way although they were of different races of *Apis mellifera* (Section 3.21).

Movable-frame hives (of an English pattern) were introduced first into Egypt, in 1880, by a Cyprian beekeeper who established an apiary of *A. m. cypria* near Cairo. He soon expanded his holdings to 1200 hives, and by 1900 the hive was in common use for both Cyprian and Egyptian bees. In 1904 some German back-opening hives were used (Lotfi, 1988). In 1912 the Ministry of Agriculture established an apiary near Giza, and in 1916 it prohibited further imports of bees without permission (Page & Laidlaw, 1980). Dr A.Z. Abushady was active in introducing modern beekeeping during the 1920s and 1930s, but by 1964 only 15% of hives in Lower Egypt and 6% of those in Upper Egypt had movable frames. By the 1980s the total number of hives had increased from 600,000 to 900,000; 56% had movable-frames.

Other North African countries started movable-frame beekeeping much later. Persohn (1955) wrote about Algeria, where P.J. Baldensperger had Dadant hives by 1921. Haccour (1939) had 500 in the Gharb region of Morocco; by 1964 (Figure 41.7a) he had 2000, and in that year I went with him to take the

Figure 41.7a One of Paul Haccour's apiaries in a *Eucalyptus* plantation, Gharb, Morocco, 1964 (photo: E. Crane).

first movable-frame hives to Tafilalet oasis in the Sahara. Dadant hives were also used in Tunisia, probably from around 1950. Langstroth hives were imported into Libya from England in 1952, and were used until the late 1960s by Olive Brittan, Beekeeper to King Idris; she described the beekeeping in 1955/56.

Available figures (Crane, 1990a) suggest that by the 1980s less than half the hives in the whole region had movable frames, and Morocco (total 323,000) only 16%.

41.72 Tropical Africa

The region discussed here extends from the Sahel in the north to the Limpopo River in the south, and Sections 28.2 to 28.5 describe its rich traditional beekeeping. Many areas were little affected by the existence of movable-frame hives, whose use started only a few decades ago; Table 36.4B gives some dates. Figures available are incomplete (Crane, 1990a), but in the 1980s movable-frame hives probably represented less than 10% of the total in Ethiopia, Zambia, Rwanda and Burundi (Paterson, 1989). Reasons for the small change to modern beekeeping include the following.

- There was long experience with traditional beekeeping, which had been developed in ways suited to tropical African bees and conditions.
- Many of the bees (e.g. *A. mellifera scutellata*) were easily alerted to sting, so beekeeping was easier with scattered hives than with hives close together on the ground, in an apiary.
- Traditional hives were fixed high up in trees where temperatures were more equable than on the ground, and this was impracticable with frame hives.
- Movable-frame hives were expensive, and most effectively used with accessories which were also expensive.
- Hives (even expensive ones) might be occupied for only part of each year, because many colonies absconded when forage became scarce, and found new forage elsewhere.
- From 1967 cheaper top-bar hives were developed in Kenya and spread to other countries (Section 40.8; also Drescher & Crane, 1982).

Where movable-frame hives were introduced, it was usually by an enthusiastic officer or administrator – later an aid worker – from a temperate-zone country where European *A. mellifera* was kept in such hives. He may have been able to operate the hives effectively and profitably, but the operation often deteriorated after he left. However, if he published a book or bulletin describing what had to be done, the introduced beekeeping had a better chance of surviving.

The following paragraphs give an idea of the impact of movable-frame hives in individual countries, in order from north to south, first in the east and then the west. In eastern Africa, Ethiopia had a few movable-frame hives from 1962, some of a German type, but by 1986 only some 6000 of its 2.5 million hives had frames. Gebreyesus Mammo (1976) taught himself how to change from traditional to modern beekeeping; he learned the value of the more equable climate inside a bee house, and also how to forestall absconding by his colonies: at the appropriate season he moved the hives between the bottom of the Rift Valley and Addis Ababa at the top. Figure 41.7b shows an apiary farther west.

Movable-frame hives were introduced to Kenya about 1928, and by 1962 European settlers probably operated over 1000, mostly Langstroth, but a few Dadant. From 1967, aid projects using top-bar hives

Figure 41.7b Apiary in which all hives were on suspended platforms to prevent access by ants, Western Ethiopian Highlands, 1973 (photo: E. Crane).

Figure 41.7c Dr F.G. Smith's bee house, Tabora, Tanzania, 1973 (photo: E. Crane).

(Section 40.8) turned attention away from frame hives, and also led to the production of several intermediate hives: a Langstroth hive for top-bars instead of frames (Paterson, 1988); a modified African long (single-storey) hive; and a transitional hive with which a beekeeper could progress from top-bars to frames (Townsend, 1976). In Tanganyika, box hives (some probably with frames) were introduced around 1900 during German colonial times. Dr F.G. Smith was Beeswax Officer from 1949 to 1963, and his 1960 book is the best exposition of movable-frame beekeeping in tropical Africa. In his experience modified Dadant hives were better than Langstroth, provided the colony could fill the brood box with brood. He used Dadant hives in a bee house he built at Tabora (Figure 41.7c), and also designed an African Dadant hive (1961b). But in 1982 less than 1% of the hives in Tanzania had frames.

On the west side of Africa, movable-frame hives were tried in Senegal in the early 1960s; in Ghana they were first used in 1963 (Gorenz, 1979). Top-bar hives were later promoted and used, but in the 1980s better results were obtained with a slightly modified Langstroth hive, and Ghana Bee News (1987) set out advantages and disadvantages of the two hives. In the Belgian Congo, now Zaire, Dubois and Collart (1950) described a long single-storey frame hive and a 'Congolese' hive with square frames. Portugal Araújo (1974) carried out development work in Angola, where Dadant hives were among those used from 1956. In Rwanda in 1952, Bauduin (1956) promoted Langstroth hives and obtained some high honey yields; 400 apiaries of them were established by 1967, and there were to be 25,000 hives by 1980. Later, an aid worker found top-bar hives more suitable (Clauss, 1987), but in Burundi there were 5000 frame hives in Cibitoke in 1981. Villières (1987) gave further information.

Farther south in Zambia, Dr F.G. Smith believed that the small amount of movable-frame beekeeping done by Europeans up to 1957 could be much expanded. Silberrad (1976) used Dadant hives there for some years, and also a single-storey frame hive.

In Rhodesia, now Zimbabwe, Penelope Papadopoulo from Greece used Langstroth hives from 1959 (Figure 41.7d), and C.J. Coleman developed large-scale honey

Figure 41.7d Penelope Papadopoulo examining a Langstroth frame in which pieces of brood comb from a traditional hive had been tied, Rhodesia (now Zimbabwe), 1959.

production and a planned queen rearing programme based on her teaching. He populated hives with swarms from natural nests, caught in 500 trap hives set up in surrounding districts; he immediately requeened the swarms with queens he had reared and allowed to mate in an area 'flooded' with drones from selected stock (Crane, 1990a, p. 249). By 1986 he had 850 colonies, and also reared 6500 queens annually (Parker, 1986). This operation was more similar to some in South Africa than any other I know in tropical Africa.

41.73 South Africa

The climate of Africa south of the Limpopo River is less tropical than that farther north. Also, Europeans settled near the southern extremity relatively early, Dutch from 1652 and British from 1806, and in the 1830s Dutch peasant farmers (Boers) moved north to the interior. When movable-frame hives became available, some people of European descent started to use them.

Eddy Lear searched for early records of movable-frame hives in South Africa, and the first he found was in Port Elizabeth in 1878. 'The hive consisted of four sections, each containing two frames about the size of an English standard, with nail [frame] spacing and hanging. Each section had a removable outer side, leaving a wall of glass for observing.' Honey was stored in 'a top section with comb starters in the frames. ... From this primitive hive we took some fine thick frames of honey free from brood or pollen. The comb used to be cut out leaving a starter of about an inch [2.5 cm]' (Titterton, 1912). Attridge's 1909 beekeeping book was probably the first for South Africa.

Because of the bees' absconding and swarming propensity, beekeepers learned to set out bait hives at the appropriate season, usually several metres above ground level. Swarms occupied them, and were used to populate empty hives. In an attempt to prevent their colonies absconding, some beekeepers fastened a queen-excluder sheet across the hive entrance, so that the queen could not leave.

From about 1970 a few beekeepers had top-bar hives, for instance in Natal and Swaziland. Robin Guy (1971) in Natal used cheap top-bar brood boxes and bait hives with the same cross-section as a 10-frame Langstroth hive, so that he could place Langstroth supers on them; see Figure 41.7e.

In the extreme south of the Cape area, the native honey bee is *Apis mellifera capensis*. It builds smaller colonies than *A. m. scutellata*, and is a mild-tempered bee, which is somewhat easier to handle and manage, except for unusual aspects of its colony reproduction (Section 3.22). Around 1990, beekeepers migrated many colonies of *A. m. capensis* into *A. m. scutellata* territory; this led to the production of hybrids between the two races, and resulted in much trouble for the beekeepers (Allsopp, 1993); see Section 36.61.

Figure 41.7e Top-bar brood box used with Langstroth supers, Natal, South Africa, 1973 (photo: E. Crane). Robin Guy has taken off two supers (on the right) and is removing the queen excluder.

41.8 The transformation of world beekeeping

Langstroth's production of a workable movable-frame hive in 1851 proved to be a watershed in the history of world beekeeping. The next few Chapters (42-45) indicate how beekeeping subsequently developed, in ways that could not previously have been envisaged. New inventions were generated which enabled beekeepers to use the hive to build up much larger colonies and obtain much larger honey yields. The same honey-storage combs could be used again and again, and this reduced the weight of wax the bees secreted – from 8-10% of their honey production to less than to 2% – releasing proportionately more energy for honey production. Various mechanical advances from the late 1800s onwards enabled a single beekeeper to operate many hundred or even a few thousand hives, and transport them to a succession of honey flows.

In general, the most suitable size for a (deep) brood box in the late 1800s became too small by the mid-1900s, because importations of different races and

subsequent bee breeding had led to the production of more prolific queens. So it became customary in many countries for large-scale beekeepers to use two or more such boxes for the brood nest; some small-scale beekeepers used one deep and one shallow box. Section 43.5 describes Demaree's 1892 system of management using two brood boxes.

Crane (1990a) gave current dimensions of standard deep and shallow boxes and frames of hives including Langstroth, Modified Dadant (i.e. Jumbo) and Dadant-Blatt. In 1951 Campbell estimated that the Dadant 'may be the most used frame in the world'; by 1990 hives of the Langstroth and Dadant types were certainly the most common. The Langstroth type of hive and frame was then used in the following countries, among others.

More or less exclusively:	*Widely:*	
Argentina	Albania	Japan
Australia	Brazil	Mexico
Canada	Chile	Portugal
China	Greece	Romania
Egypt	Iran	Spain
New Zealand	Israel	Turkey
South Africa	Italy	USA
	many others in Latin America	

It is a great tribute to the two beekeepers in the USA – Langstroth and Dadant – that the patterns of the movable-frame hive they developed in the 1850s and 1860s are still used so widely and so effectively, and have not been superseded.

Table 41.8A shows the number of hives and the honey production in different regions during the late 1900s. The productivity of beekeeping, measured by the honey yield per hive, was in general higher in the more sparsely populated regions to which honey bees were taken by man (the Americas and Oceania) than in regions where they had evolved (Africa, Europe, Asia). Between 1971 and 1984, both the total world honey production and the number of hives increased by about 20%, and by the 1980s the world was officially producing around a million tonnes of honey a year. Also, advances in food technology had made it possible to handle large quantities of honey, and to transport it round the world, from regions where much was produced to those where much was consumed (Section 46.44).

Table 41.8A

Beekeeping and honey production in the late 1900s: approximate world data

Based on Table 1.5B in Crane (1990a), which explains the origins and shortcomings of entries.

Region	*Area (million km²)*	*No. hives (millions)* c.1971	*No. hives (millions)* 1984	*No. hives /km²* 1984	*Honey production (1000 tonnes)* 1971	*Honey production (1000 tonnes)* 1984	*Honey yield (kg/hive)* 1984
Europe	4.8	13.0	15.1	3.2	122	165	11.0
USSR	22.4	10.0	8.2	0.37	220	193	23.5
N America	19.3	4.8	5.0	0.26	158*	118	23.7
C America	2.7	1.7	3.5	1.3		87	24.7
S America	17.8	2.3	4.1	0.23	37	57	14.0
Oceania	8.5	0.7	0.8	0.10	25	31	38.5
Asia	24.6	6.0	13.2	0.53	241	246	17.5
Africa	25.3	14.0	13.5	0.53	25	95	8.1
World totals	125.4	52.5	63.4	0.51	828	992	15.3

*Includes Central America.

42

History of Beekeepers' Associations and Beekeeping Journals

42.1 Introduction

Most of the Beekeepers' Associations and beekeeping journals or periodicals we know today were founded after 1853 when Langstroth's book was published. They were a consequence of the introduction of beekeeping with movable-frame hives, which gave more varied possibilities than beekeeping with traditional hives. The Associations and journals, which offered instruction and encouraged the exchange of views and experiences, played an important part in the development of modern beekeeping. Table 42.4A lists 18 journals that were started in or before 1895.

Although the earliest Beekeepers' Association or journal founded in a country might cease, another usually took its place, so there was a more or less continuous sequence of activity. Associations and journals proliferated at an ever-increasing rate, and many hundreds of both have existed. Sections 42.3 to 42.8 describe their genesis in different parts of the world during the formative period of modern beekeeping. But first, Section 42.2 gives a brief history of a few organizations and journals before 1853 that related to beekeeping.

42.2 Pre-1853 organizations and journals relevant to bees and beekeeping

42.21 Learned societies

From the 1600s onwards, individuals in certain European countries who had a common interest in science and agriculture formed themselves into societies so that they could exchange views and news of fresh discoveries, and visit each other's establishments. These societies did much to promote the advancement of their subjects of interest, and some of their members were interested in bees and beekeeping, so the societies might also become involved. Early learned societies included the following:

Founded	*Country*	*Name*
1603	Italy	Accademia dei Lincei
1660	England	Royal Society
1666	France	Académie Royale des Sciences
1731	Ireland	(Royal) Dublin Society
by 1757	France	Société d'Agriculture, de Commerce, et des Arts, établie par les États de Bretagne
by 1764	Switzerland	Société Économique de Berne
1772	Belgium	Académie Impériale et Royale des Sciences et Belles Lettres de Bruxelles
1819	Russia	Imperial Moscow Agricultural Society
1826	England	Zoological Society of London (see Figure 42.2a)
1838	England	Royal Agricultural Society of England

Figure 42.2a Interior of the apiary in the Gardens of the Zoological Society of London, founded in 1826 (Neighbour, 1865).

In Russia, beekeeping had been advanced through the Imperial Free Economic Society from 1765, and through various Agricultural Societies from 1819 (Galton, 1971).

42.22 Local beekeepers' organizations and journals

Organizations considered here fall into three groups: mediaeval-type trade guilds; communal teaching and learning societies among educated men; and societies for improving the lot of the rural poor by getting them to keep bees.

Beekeepers' Guilds

From the 1400s, Beekeepers' Guilds with a written constitution and statutes were established in various towns of Brabant (now in the Netherlands and Belgium), to look after the organization and rights of beekeepers; many of them were named after St Ambrose as the patron saint of beekeepers (Section 54.5). Vrancken (1962), Cruyce (1968) and Nimberg (1970) described the following, some of which are still active, and there were others.

1486 Beekeepers' Union (Bond) of Zelem, now in Belgium.
1633 Beekeepers' Guild (Gilde) of Oosterhout near Breda, Netherlands, started in a small way by the priest of St John's Church.
1695 Beekeepers' St Ambrose Guild in Mortsel.
1670 Larger Guild of professional Oosterhout beekeepers whose statutes were approved and signed by Willem Hendrik, then Prince of Orange and Lord of Breda and Oosterhout, and later King William III of England.
1714 Beekeepers' St Ambrose Guild of Made, Netherlands.
1847 St Ambrose Guild of Hasselt, Belgium.

A Guild regulated the general life of its members as well as their beekeeping. For instance in Zelem in 1486 the lord had the right to take half of any swarm found, or a tax of 1 shilling or more. All swarms had to be reported to the bailiff, and the penalty for not doing so was confiscation of the swarm. When beekeepers took hives into an area in the spring (to prepare for the heather later), they had to pay the lord 3 groats per hive, plus 1 groat for every 10 swarms. If hives were not taken until late summer, the tax was 3 stuivers.

In the Guild established in 1714 in Made in North Brabant (Netherlands), a member who found a swarm had to search for hives within 150 metres of it; if he found none he could take the swarm, otherwise he had to report the swarm or return it to its presumed owner. If he failed to do so, he was fined 3 guilders and had to await a judgment from the head of police. Members were required to meet on St Ambrose's Day (7 December). They all received a meal on two days, and bachelors and widowers intending to marry had to give the members a barrel of beer. Members had permission from the authorities to practise archery by shooting birds with a foot-bow – which ensured a supply of trained archers when these were needed (Oome, 1993).

German-language organizations, 1296-1852

In some forested parts of Germany there were organizations of tree beekeepers (*Zeidler*, Section 16.25). One in the Nürnberger Reichswald existed as early as 1296, and maintained its own *Zeidler* law court in Feucht. In 1226 the monastery Kloster Dobrilugk in Prussia (founded in 1165) had acquired much land in which tree beekeeping was done, and by 1315 these *Zeidler* owed allegiance jointly to the monastery and to Bodo von Ileburg who rented the land. Their organization had its own jurisdiction, and at a trial in 1315 some of the *Zeidler* were ordered to pay compensation for damaging a heath, half of which went to the monks and half to Bodo. From 1492 there was a *Zeidler* organization in the Lordship of Hoyerswerda in Finsterwald south of Berlin (Schwärzel, 1954).

The earliest type of teaching organization for hive beekeeping was the German *Bienengesellschaft* (Schwärzel, 1987), usually led by a Pastor. The first, founded in 1766 at a meeting of leading beekeepers in Kleinbautzen under the leadership of A.G. Schirach who acted as its Secretary, was the Kurfürstlich-Sächsische Physikalisch-ökonomische Bienengesellschaft. Its aims were communal teaching and learning about beekeeping, giving advice and actively putting it into practice, exchanging views – and also healing rifts that arose between certain beekeepers. Several similar organizations followed, each with a leader who provided the motive power. In 1767 J.L. Eyrion founded the similarly named Fränkische Gesellschaft and became its Secretary. In 1770 Adam Bernhard founded another in Rotha near Leipzig, and both these bodies were members of the Oberlausitzer Bienegesellschaft in Bavaria. In 1783 a Pfalzbayerische patriotische Bienengesellschaft was founded in Munich; it served both 'garden beekeepers' who used hives, and 'forest beekeepers' who used nests in trees as described in Section 16.25. Huish referred to this organization in 1815: peasants in Bavaria were not allowed to have their own apiaries, and 'different proprietors deposit their hives – up to 150 – at a spot indicated by the Patriotic Apiarian Society of Bavaria ... under the management of a

skilful apiarian.' Peasants could be instructed in the use of one or more of these hives, by arrangement.

These organizations and later ones (Schwärzel, 1987) aimed to improve beekeeping through a better knowledge of the life of bees and better methods for managing them. There were similar bodies in Austria. In 1769 Empress Maria Theresa negotiated through the Niederösterreichische Gesellschaft für Landwirtschaft for the appointment of a beekeeping teacher, Anton Janscha, and in 1782 a Beekeepers' Association was founded (Brauneis, 1960). Huish (1815) mentioned an apiary in Vienna with 100 hives, maintained 'for the instruction of the peasants, under a bee master named Pösl'. On days with lectures, 'it is generally frequented by young men intended for the clerical life, who are obligated to attend them, that they may impart their knowledge to their parishioners. A regular journal is kept ...'.

Several beekeeping journals were published in German before 1853, two by Beekeepers' Associations:

1799-1805 *Journal für Bienenfreunde* (pub. I.L. Büsching)
1838-1843 *Monatsblatt für die gesamte Bienenzucht* (pub. Landshut, Niederbayern)
1845 *Nördlinger (Eichstädter) Bienenzeitung* (pub. Verein deutscher Bienenwirthe)
1850 *Vereinsblatt*, later *Rheinische Bienenzeitung* (pub. Rheinisch-Westfälischer Verein für Bienen- und Seidenzucht); see Table 42.4A, and Mandrella's detailed history (1974).

Britain and Ireland, from 1790

One aim of beekeepers' organizations founded here before 1853 was mutual self-improvement, and this was coupled with a strong urge to better the lot of the rural poor – who were to be encouraged to keep bees – and also to raise the standard of beekeeping, and harvest honey without killing the bees.

In or before 1796 Dr J.C. Lettsom, physician and philanthropist, published an 8-page leaflet in London, *Hints for promoting a Bee Society*.

> I wish to excite patronage of the industrious bee, by the institution of a society for promoting its increase, not only in the neighbourhood of London, but likewise throughout the kingdom ... With our present agricultural improvements, and increasing horticulture, ... a Bee Society will not be deemed the least important institution of the present period.

The author knew about carpentered glass hives (Chapter 37), but was chiefly interested in putting 'a little honey on bread' for every family, which 'would save the use of butter on the occasion, and be more wholesome'. His Bee Society was to increase the number of colonies of bees, and to help poor people to keep them. Dr Lettsom's ideas seem to have been acted on in various parts of the British Isles. In 1797, the year after an enlarged second edition of the leaflet appeared, the Wrexham Agricultural Society in Wales offered twelve premiums (prizes) to cottagers who raised the greatest number of hives of bees before 1 September (Crane & Walker, 1984/85). In 1801 the Dublin Society awarded premiums to the six beekeepers in Ireland who had overwintered the most colonies – 128 colonies altogether, in Waterford, Tipperary, Louth, and King's County, now Offaly (Huish, 1815). The Hamilton Bee Society was formed in Scotland, but nothing is known about it.

At least four Beekeeping Societies were formed in England. The Western Apiarian Society, founded in 1799 in Exeter, Devon, published its *Rules* in 1799 and 1807, and *Transactions* more or less annually from 1800 until 1809, when the Reverend J. Isaac, its Secretary, wrote in his copy 'The Society has been dissolved' (IBRA, 1979). Isaac's book *The general apiarian* (1799, 2nd ed. 1803) was dedicated to the Society 'who, for the benefit of their country, and especially of the poor cottagers, have stood forward in the defence of the bee ...'. The 128-page book was 'a small tract, for the use of common people, who cannot afford money to purchase, or time to peruse the treatises already published'. Fraser (1958) gave more details.

Later came the British Apiarian Society, founded by Huish in 1819 'for the promotion of the culture of the bee amongst the cottagers', the Suffolk and Norfolk Apiarian Society which existed in 1832, and the Oxford Apiarian Society. This last was proposed in 1833 by W.C. Cotton, and his 1842 book published the Society's Rules, with information on its activities up to 1839. It also reprinted *A short and simple letter to cottagers*, which Cotton wrote in 1837 under the pen-name 'A conservative beekeeper'. This was one of the earliest uses of the word beekeeper after Bromwich's 1783 book *The experienced beekeeper*, and Bone (1967) suggested that it helped to extend the use of the word.

42.3 Characteristics and activities of post-1853 Beekeepers' Associations

A new situation arose with the introduction of movable-frame hives in a country (Chapter 41). The better educated beekeepers were excited about fresh

possibilities suddenly opened up, and they wanted to share with each other their experiences and achievements. So in one country after another a specialist Society was formed.

Sometimes local or regional Associations were formed and later amalgamated into a national one; sometimes it was the other way round. The Associations spread the use of movable-frame hives, promulgated new ideas, and encouraged beginners. Their meetings and journals also provided more opportunities for women to learn and practise beekeeping (Section 53.5). Beekeepers tend to be independent by nature, and in some Associations rival factions developed, each led by a strong-minded man who was unwilling to renounce his leadership; throughout the history of Beekeepers' Associations, such factions and splits wasted much effort and goodwill.

Undated statements below are based on what I learned during visits to different countries from 1949 onwards. In some European countries with a long and vigorous tradition of beekeeping, a large proportion of beekeepers became members of the post-1853 Associations. Membership was therefore high, and dues collected were sufficient to maintain a central office with a fully paid staff. In other countries there were fewer beekeepers, less than half of them were members, and the Association depended on voluntary officers who worked without payment.

Associations organized meetings, apiary visits, and conferences in conjunction with an agricultural college or some other institution. Many of the larger Associations published a newssheet or journal (see Sections 42.4 to 42.8), and some also issued educational and promotional material.

One of the first aims of many early Associations was to encourage a high standard in honey and beeswax offered for sale. Competitive 'honey shows' were combined with exhibits of beekeeping equipment and of educational material for the public. The most important was probably the National Honey Show in London which was started in 1874 and grew to attract entries from all over the world. The British Bee-Keepers' Association organized the 1874 Show, and a larger one in 1886 at the Indian and Colonial Exhibition in the Albert Hall in London, which had 350 honey entries. Shows were often opened by eminent people, for instance David Lloyd-George who had been Prime Minister (Figure 42.3a). Cowan (1928) published photographs of early London exhibits, and Figure 42.5a shows displays of a similar kind in Canada in 1926. Exhibits were also staged at agricultural and other shows (Figure 42.3b).

Benefits which encouraged membership of an Association might include facilities for buying – sometimes at reduced prices – sugar or appropriate drugs for feeding to bees. In some countries, including Romania and Norway, the national Association stocked and sold hives and other beekeeping equipment as a money-earning business enterprise, which

Figure 42.3a Part of a group photograph at the opening of the National Honey Show at the Crystal Palace near London, 1936 (photo: S.W. Gadge). *Front row:* Earl Lloyd-George (centre), D.L. Bryce on his right, W.E. Hamlin on his left.

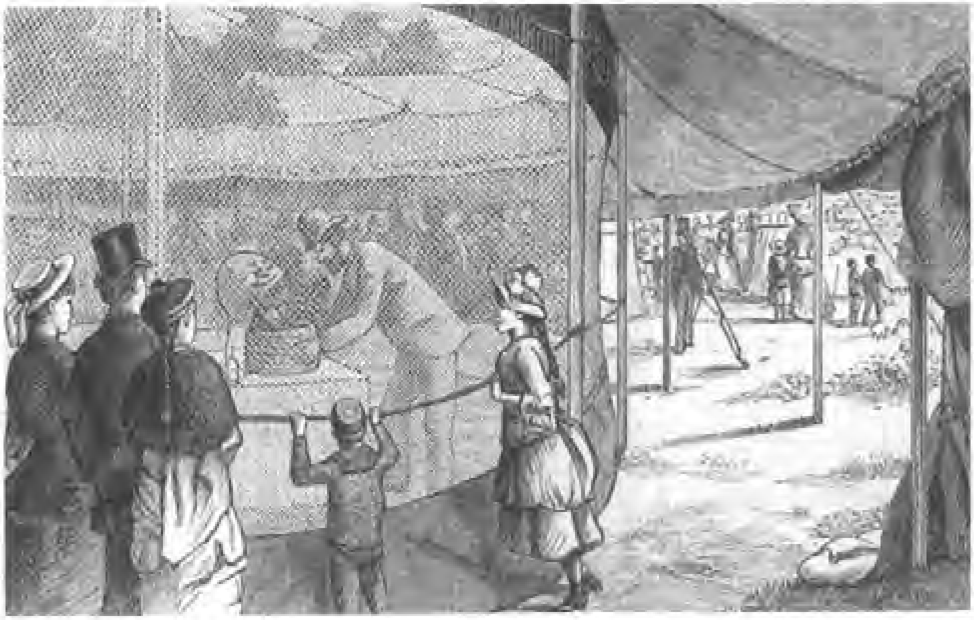


Figure 42.3b 'Bee tent' organized at a Show in England, by the local Beekeepers' Association (Jenyns, 1886).

enabled it to expand its operations. A few Associations operated an insurance scheme against theft, or against compulsory destruction of bees and hives because of a contagious disease. (The Imkerorganisation Hannover in north Germany formed the first 'Bee Insurance Society' in 1860, and in 1864 it had 1127 members.)

Many local Associations maintained an apiary for demonstrations and meetings; see Figure 42.2a. Around 1860 the Apiarian Society of London, which had Tegetmeier as its Secretary (see Richardson, 1916), erected the 'Experimental bee house' shown in Figure 42.3c. A few larger Associations – especially in Germany – established a mating apiary in an isolated site such as an island, where selected drone-producing colonies were maintained, and members could take or send virgin queens they had reared, each in a small mating hive.

Many Associations were instrumental in getting national standards established for hives, frames and other equipment. A few, especially the British Bee-Keepers' Association, developed a system of

Figure 42.3c Engraving entitled 'Experimental bee house, Muswell Hill, Hornsey. Erected for exhibiting the working of scientific and improved hives by the Apiarian Society. W.B. Tegetmeier, Hon. Secy.'

beekeeping examinations leading to qualifications such as Master Beekeeper.

The Société Romande d'Apiculture in Switzerland encouraged good design and maintenance of members' apiaries, by organizing an annual competition in which apiaries were judged from photographs submitted.

Finally, a strong national Association was in a position to represent beekeepers' interests to government departments. After the European Community was set up, the Commission of the Professional Agricultural Organizations (COPA) looked after the interests of large-scale beekeepers.

42.4 Beekeepers' Associations and journals in Europe

Beekeepers' Associations proliferated first in the region where German was the official language: Germany, Austria and other parts of the Austro-Hungarian Empire such as Slovakia and Hungary, and also Switzerland. An Association had been formed in Germany in 1850, following Dzierzon's introduction of a back-opening hive with top-bars; the Wiener Bienenzuchtverein in Austria started in 1860, the Swiss Verein Schweizerischer Bienenwirte in 1861, and an Association in Saxony in 1863.

As time went on, more national and regional Associations were formed. In Germany especially, regional Associations and later the national Deutscher Imkerbund were powerful, and operated under a strong leadership. The same was true in Czechoslovakia, and also the Netherlands – where, however, two Associations were formed, one by Roman Catholics and the other by Protestants. In Belgium, Dutch-speaking Flemish beekeepers formed one Association, and French-speaking Walloons another. In Switzerland an Association existed for each language group, German, French and Italian; the first was the most active.

Perhaps the last European country to establish an Association – in 1953, with 12 members – was Iceland (Kristjánsson, 1992). Bees had been reintroduced in 1951 (Section 36.43), but they died out after a few years.

In addition to journals published by Associations, others were produced by individuals, book publishers, or beekeeping supply establishments. Figure 42.4a shows how the publication of beekeeping journals later spread outwards from a mainly German-speaking central area, which included also France and Italy. All countries in this area had a beekeeping journal before 1870; countries immediately surrounding these started one by 1890, and outlying countries of Europe did so afterwards.

Figure 42.4a Map of Europe showing where beekeeping journals were started at different periods during the late 1800s. *vertical hatching* before 1870: 1850 Germany; 1854 Czech lands; 1856 France; 1866 Denmark; 1868 Italy; 1869 Austria and Switzerland. *horizontal hatching* before 1890: 1871 Sweden; 1873 UK; 1874 Poland; 1880 Hungary; 1882 Yugoslavia [*Pchela*]; 1883 Belgium; 1885 Norway; 1886 Luxembourg; 1886? Romania; 1888 Minorca; 1889 Netherlands. *dotted* 1890 and later: 1892 Spain; 1901 Bulgaria; 1908 Russia; 1914 Finland; 1919 Latvia; 1937 Estonia; 1958 Portugal; 1986 Canaries (Spain); also Greece

All the journals in Table 42.4A (15 in Europe and 3 in North America) continued long enough to have celebrated their centenary, an occasion usually marked by the publication of historical material.

Other journals which started early, but did not last as long, include:

1854 (present Czech Republic) *Vrela Brnenská* in Czech, *Die Honigbiene von Brunn* in German, both published in Brno by the Moravian Beekeepers' Association.* A Bohemian Association was started in 1852.

*Gregor Mendel, Abbot of Queen's Monastery in Brno, who formulated the laws of heredity in plants, was a supporting member of this Association and, for a short time in the 1870s, an active Vice-Chairman of Brno Beekeepers' Association (Veřerek, 1965; see also Orel *et al.*, 1965).

Table 42.4A

Eighteen beekeeping journals which have been published for more than a century

Journals marked * were published by a Beekeepers' Association.

Started	*Present country*	*Title*
	Europe	
1850	Germany	*Westfälisch Rheinisches Vereinsblatt für Bienenzucht* *, became *Rheinische Bienenzeitung*
1856	France	*L'Apiculteur**
1862	Germany	*Mitteilungen über Bienenzucht* ... *, became *Die hessische Biene*, combined with *Vereinsblatt* ... (1st entry) in 1897; became *Die Biene*
1863	Germany	*Die hessische Biene**, combined with *Die Biene* (previous entry) in 1936
1863	Switzerland	*Schweizerische Bienen-Zeitung**
1864	Germany	*Die Biene und ihre Zucht* *, became *Südwestdeutsche Bienenzeitung*
1865	Germany	*Der Niedersächsische Imker* *
1866	Denmark	*Tidsskrift vor Biavl* *, became *Biavl*
1867	Czech Republic	*Cesky Vcelár* *, became *Vcelár*
1869	Austria	*Der Bienenvater* *
1873	UK	*British Bee Journal*
1882	Yugoslavia	*Pchela*
1885	Norway	*Tidsskrift for Biskjøtsel* *, became *Birøkteren*
1886	Luxembourg	*Luxemburgische Bienenzeitung* *, became *Letzebuerger Beien Zeitung*
1895	Austria	*Mitteilungen über Bienenzucht* *, became *Oberösterreichische Imker* in 1936
	North America	
1861	USA	*American Bee Journal*
1873	USA	*Gleanings in Bee Culture* became *Bee Culture*
1885	Canada	*Canadian Bee Journal* *, some years *Canadian Beekeeper*

1854 (Silesia) *Bienenfreund aus Schlesien* (to 1856) published by J. Dzierzon.
1868 (Italy) *L'Apicoltore* (several Associations were formed around 1870).
1880 (Hungary) *Ungarische Biene* (German), *Magyar Méh* (Hungarian).
1892 (Spain) *El colmenero espagñol*.

Droege (1962/68) listed ten other German journals starting between 1863 and 1890, of which five lasted into the 1940s; she also cited several other lists of German bee journals. At least forty beekeeping journals were published in Hungary (Örösi-Pál, 1965).

In England, the *British Bee Journal* was started by C.N. Abbott in 1873. At a meeting in London in 1874, 'the gentlemen present [including C.N. Abbott and F. Cheshire] constituted themselves provisionally into a Society called the British Bee-Keepers' Association, and took over from the Editor of the *Journal* the organization of a 1874 show at the Crystal Palace' (Cowan, 1928). The proposed objects of the BBKA were to be 'the encouragement, improvement and advancement of bee-culture in the United Kingdom, particularly as a means of bettering the condition of cottagers and the agricultural labouring classes ...'. A local Society had been formed in England in 1867: the Buxton Bee Club in Derbyshire; cottagers who paid 3d. a week regularly to the Club for a whole year gained a 5s. bonus, giving a total of 18s. (nearly £1) to spend on bees and hives (Cowan, 1928).

In later years the number of different journals in central Europe probably ran into several hundred, and many more were founded in other parts of Europe. Annotated lists of journals have been published (Miller, 1897; Schmidt, 1921; Frykholm, 1950, 1951; Milum, 1954; Crane, 1955). By 1990 national Beekeepers' Associations were operative in at least 70 countries in the world, and 43 published one or more journals (listed by Crane, 1990a).

42.5 Beekeepers' Associations and journals in the USA and Canada

The first Beekeepers' Association in North America, the Pacific Apiarian Society, was formed in winter 1859/60, to deal with problems resulting from the large number of hives taken to honey flows in the Sacramento area of California. Nearly 6000 incoming hives resulted in a total of 15,000 in the area, which greatly overstocked it; also some colonies already there were infected with *Bacillus larvae* (American foul brood disease). J.S. Harbison was a

Figure 42.5a Exhibition by British Columbia Honey Producers' Association, New Westminster, 1926 (photo: Stride). Each of the four commercial displays at the back contained a quarter of a tonne of honey; W.H. Turnbull's (far right) won the first prize of $100.

leading member of the Society. It ceased in late 1860, but another – the North American Bee-keepers' Society – had already been formed at Stockton in California. It was especially active in Michigan and Ohio, and lasted until 1884 or later; Newman (1886) published a detailed history of its meetings and proceedings, and Watkins (1970) also gave details. In 1885, a National Beekeepers' Union was organized, with the specific purpose of settling disputes and defending the legal rights of members in the courts; Section 41.2 refers to the many patents taken out by beekeepers at this time. Georghiou (1955), Milum (1964) and Moffett (1980) documented some of the other early Beekeepers' Associations in the USA.

Beekeepers in North America were scattered over much larger areas than those in Europe, and it was more difficult for them to meet together. Perhaps for this reason, in early days journals fared better than Associations, although both started during the first few years after movable-frame hives came into use. Many of the short-lived journals were absorbed by others. At least 58 were started between 1860 and 1900, and at least 33 between 1900 and 1930. The Iowa State Apiarist's Report for 1930 listed the following numbers of journals that began in successive decades up to 1900.

	1850s	1860s	1870s	1880s	1890s	1900-1910
USA	—	6	12	15	21	10
Canada	—	—	—	2	2	—

Journals were in English except two in Canada, *L'Abeille* (1928) in French and *Pasika* [Apiary] (1924) in Ukrainian, and one in the USA, *Amerikai Meheszet* (Indiana, 1926) in Hungarian. The last two were intended for recent immigrant beekeepers.

Important early journals were published by beekeeping supply firms whose customers were usually widely dispersed. The earliest was *American Bee Journal*, started in 1861 by Samuel Wagner in Philadelphia, suspended during the American Civil War (1861-1865) and restarted in 1866. Various publishers issued it before 1912, when it was taken over by the beekeeping supply firm of Dadant at Hamilton in Illinois, which still publishes it. York's *The story of the American Bee Journal* (1904) provides many sidelights on contributors, but few on its history. C.C. Miller wrote about 'Defunct bee journals' in 1897.

In Canada, the Red River Apiarists' Association in Manitoba was founded in 1870, and the first journal (the *Canadian Bee Journal*) was started in Ontario in 1885; although there were some early interruptions and slight changes in its title, it is still published. *The practical Bee-Keeper* was started as a new series in 1894, and *L'Abeille*, later *L'Abeille et L'Érable*, in 1919 in Quebec. The Ontario Honey Producers' Cooperative – the first such organization in North America – was founded in 1923 to handle honey sold by large-scale beekeepers. Associations were later formed in other Provinces, and Figure 42.5a shows exhibits of an Association in British Columbia.

42.6 Beekeepers' Associations and journals in the rest of the Americas

At first beekeeping was included in some agricultural journals: in Brazil *Characas e Quintais* probably from 1895, and in Argentina *Gaceta de Granja* from 1914. Associations of German-speaking beekeepers in Brazil published the first beekeeping journals there: *Brasilienische Bienenpflege* from 1897 and *Der Deutsche Imker* in Paraná from 1933. The earliest known journals in other countries were mostly in Spanish:

South America		
1919	Chile	*Chile apícola**
1924	Argentina	*Gaceta del Colmenar**
1931	Brazil	*Nossos Colmeães* (Portuguese)
1939	Uruguay	*Revista de Apicultura**
1949	Peru	*La Colmena escolar*
1953	Bolivia	*Hoja informativa*
1960	Venezuela	*Apicultura*
1973	Colombia	*La Abeja Colombia**
1976	Paraguay	*Informativo apícola*
1974	Surinam	*Imker Koerier* (Dutch)
Other countries		
1935	Cuba	*Apicultura*
?1947	Mexico	*Abejas**

*published by the national Association.

Beekeepers' Associations are known to have existed from 1931 in Uruguay, 1950 in Cuba, and 1966 in Venezuela; in 1990 a regional Asociación Latino-americana de Apicultores was formed, with headquarters in Uruguay. Figure 42.6a relates to a development in 1987 in the Caribbean island of Nevis, near St Kitts.

42.7 Beekeepers' Associations and journals in Oceania

In Australia the states were widely separated, and an Association was formed in each: South Australia, July 1884; Victoria, September 1884; Queensland, 1886; New South Wales, 1887; Western Australia, 1900. In 1922 Tarlton Rayment suggested that beekeepers should form a Commonwealth Society to control the buying and selling of its members' honey and other apiary products, and beekeeping equipment. This was not done, but a Federal Council of Australian Apiarists' Associations was created later on.

In 1887, at the instigation of the Beekeepers' Association, the South Australian Parliament passed the Foul Brood of Bees Act which made it illegal to keep bees in box hives.

Figure 42.6a Members of the Nevis Beekeepers' Association, after a meeting in 1987 at which it received a Certificate of Incorporation as a Beekeepers' Co-operative, shown on a design for a postage stamp issued in 1994.

Morgan (1955/58) published information on Associations and journals up to 1897. The initial Association in each state was composed of professional beekeepers, and Amateur Beekeepers' Associations were formed later by new immigrants who arrived from Europe after the Second World War. Professional beekeepers also established the Australian Queen Breeders' Association and two Pollination Associations.

The Australian Beekeepers' Journal was published by the Victoria Beekeepers' Association from 1885, and its first issue contained an advertisement for a newly formed honey co-operative in Melbourne. In 1899 Pender Bros, beekeeping suppliers in NSW, started *Australasian Beekeeper*. Both still exist, and Rayment (1922) listed other journals.

In New Zealand, *The New Zealand and Australasian Bee Journal* was published from 1883 to 1885, and other journals followed under various titles. The first National Beekeepers' Association was started in 1884.

The earliest beekeeping journal known from any of the Pacific islands was *Island Bee News* from the Solomon Islands, which started in 1986.

42.8 Beekeepers' Associations and journals in Asia and Africa

The first journals known in Asian countries include the following, each published in the language of the country:

1909	Japan	[*Beekeeper's Friend*]
1937	India	*Indian Bee Journal* published by the All-India Beekeepers' Association
1945	Turkey	*Arıcılık Dergisi*
1949?	China	[*Chinese Apiculture*]
1949?	Korea	[*Korean Bee Journal*]
1949	Israel	*Yalkout Hamichveret*
1988	Indonesia	*Apiaka*
1990	Vietnam	*Ngành Ong* published by the Beekeeping Research and Development Centre, Hanoi.

Some countries also started a Beekeepers' Association, and the Asian Apicultural Association was formed in 1989, with headquarters in Japan.

The first Beekeepers' Association in Africa may have been the Société d'Apiculture de Tunisie, which published a *Bulletin* in 1901. In South Africa a beekeepers' journal was started in 1911, and from 1921 the South African Beekeepers' Association published the *South African Bee Journal*. In Egypt Dr A. Z. Abushady (Section 42.10) founded the Bee Kingdom League in 1930 which published a journal *Bee Kingdom*.

After the Second World War *L'Apiculteur algérien* was started in 1954 and also *Rhodesian Bee News*, which later became *Bee Line*. Figure 42.8a shows an apiary demonstration at a meeting in Zimbabwe. More recent journals included *Beekeeping Newsletter* in Uganda (1987), *Ghana Bee News*, and *Apicultura* in Mozambique. The Beekeepers' Association of Nigeria was formed in 1993.

42.9 International Beekeeping Congresses and Federation

Congresses

International Beekeeping (or Apicultural) Congresses were held well before the existence of any international beekeepers' organization. After a first Congress in Belgium in 1897, a Comité International des Congrès d'Apiculture was appointed at each Congress, whose sole function was to settle the venue for the next one. The impetus for these meetings came from leading beekeepers in north-west continental Europe, where most of them were held: France in 1900, the Netherlands in 1902, Belgium in 1910 and Italy in 1911. Following the end of the 1914-1918 War, the 6th Congress was in France in 1922, and the 7th was in Montreal in French-speaking Canada in 1924. The 8th to 11th Congresses were in previous European host countries, and Switzerland was chosen for the 12th Congress in 1939, shortly before the outbreak of the Second World War.

After the War, European venues were used until 1967, when the 21st Congress was in Maryland, USA. Since 1971 European venues alternated with others: Argentina 1973, Australia 1977, Mexico 1981, Japan 1985, Brazil 1989. In 1991, shortly before the 33rd Congress was to be held in Split, Croatia, fighting broke out in Yugoslavia and the Congress had to be cancelled; it was held in China in 1993, followed by the 34th in Switzerland in 1995 and

Figure 42.8a Zimbabwe beekeepers in protective clothing at a demonstration at Henderson Research Station near Mazoe, November 1984 (photo: E. Crane).

the 35th in Belgium in 1997, a hundred years after the first.

International Federation

At the first post-war International Congress, in Amsterdam in 1949, the President L.R. Ridder van Rappard proposed the formation of an International Federation of Beekeepers' Associations under the name Apimondia. It would provide a permanent link between the Associations and enable them to work together for the benefit of beekeepers and beekeeping worldwide. A working party was set up to explore this possibility, with Dr O. Morgenthaler as Secretary. At the 14th Congress in England draft statutes were discussed (Crane, 1951), and a small organization was established. Dr Morgenthaler served as Secretary-General until 1956, and in 1954 he reported on early developments. Dr A. Zappi-Recordati held the office until his death in 1964, then Dr S. Cannamela until R. Jannoni-Sebastianini succeeded him in 1993.

Activities were at a modest level until the 20th Congress in Romania in 1965 with Professor V. Harnaj as its President, when new statutes were passed which were largely his work. They set up a more elaborate structure, with a President having a four-year term of office, an Executive Committee, and a number of Permanent Commissions. Professor Harnaj was elected President; he was also President of the Romanian Beekeepers' Association which organized the sale of honey and beekeeping appliances in the country, and was able to provide a number of facilities for Apimondia in Romania. For many years he directed both organizations into intense activity, and gave Apimondia a much greater public image; the Congresses were attended by two or three thousand beekeepers. He became ill in 1977 and died in 1988. Romanian participation was reduced and, after the revolution in 1989, the work was done under many difficulties.

42.10 International journals and Association

The first international journal was published by Edouard Bertrand in Switzerland in 1888: *Revue internationale d'Apiculture*, which had appeared since 1879 as *Bulletin d'Apiculture pour la Suisse romande*. It ceased in 1903.

Bee World was started in England in 1919 after the First World War: 'an international monthly journal devoted to the progressive interests of modern bee culture', published by the Apis Club. This was an international organization of individual beekeepers and bee scientists in different countries, formed in 1919 by Dr A.Z. Abushady, an Egyptian physician then living in England. Its members were active in the International Beekeeping Congresses; the Apis Club organized various other international conferences in Europe, and the scientific content of the contributions and publications increased. Activities of the Apis Club were reported in *Bee World*, and Abushady's biography was written by Harker (1938).

From 1929 until 1949 *Bee World* was edited by Annie D. Betts, a scientist who had done aeronautical research during the First World War. She had a wide knowledge of bees and beekeeping and was an exceptionally able linguist. During these years *Bee World* was the main international source of information about scientific publications on bees and beekeeping. From 1950 to 1983 *Bee World* was edited by Dr Eva Crane, and from 1952 to date it was published by the (International) Bee Research Association, IBRA. Between 1950 and 1961 it included *Apicultural Abstracts* (see below).

Another journal with scientific papers about bees and beekeeping, *Archiv für Bienenkunde*, was edited and published single-handed by Professor L. Armbruster in Germany from 1919 until 1962.

After the Second World War three more scientific journals were started: *Nordisk Bitidskrift* for Scandinavian countries in 1949, *Zeitschrift für Bienenforschung* in West Germany in 1950 and *Annales de L'Abeille* in France in 1958; the last two combined into *Apidologie* in 1970. From 1962 onwards IBRA published *Journal of Apicultural Research* and *Apicultural Abstracts* as separate journals. From 1965 Apimondia published the journal *Apiacta* in English, French, German, Russian and Spanish editions. *Honeybee Science* in Japanese was published from 1980, and *Bee Science* in the USA from 1991.

The Bee Research Association had been founded in 1949, largely as a result of the actions of scientists on the Research Committee of the British Bee-Keepers' Association, who understood that international scientific collaboration – possible again after the Second World War had ended – must be extended to the study of bees and beekeeping. Its early activities were described in *Bee Research Association, 1949-1974: a history of the first 25 years*, and in 1976 its name was changed to International Bee Research Association. Dr Eva Crane was Director from 1949 to 1983.

43

Inventions and Advances that made Movable-Frame Beekeeping more Productive

43.1 Production of comb honey in sections

The production of honey in 'sections' was developed in the USA between 1853 when the movable-frame hive came into use and about 1868 when the centrifugal honey extractor became available there (Section 46.22). A 'section' was a small frame which was harvested from the hive when the bees had stored and sealed honey in it, and sold as a unit. In 1857, J.B. Harbison in California used a 'section honey-box' in his Improved Chamber Hive (Figure 43.1a). His sections were made of four pieces of thin wood, and he placed two rows across the hive.

Sections were used later in some European countries, and in 1888 F.R. Cheshire in England referred to 'the advent of sections' as opening up a new era. It was not in fact necessary to have the brood combs in movable frames when producing section honey, and in Europe skeps were sometimes used (Figure 38.3g).

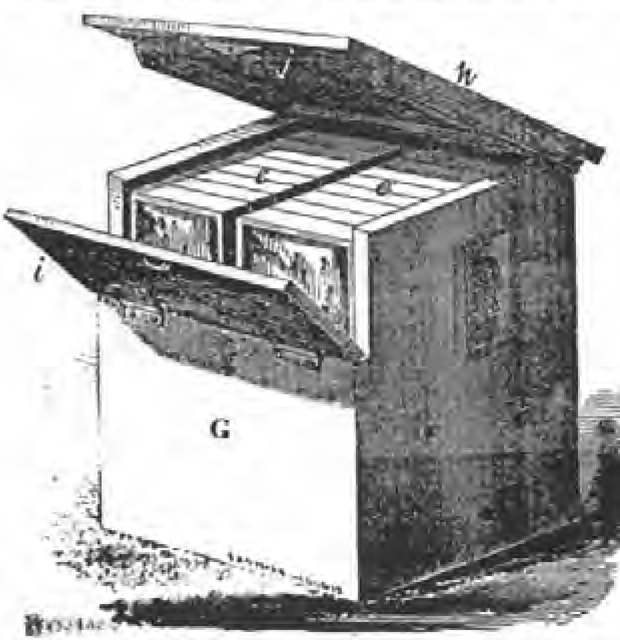


Figure 43.1a J.B. Harbison's Improved Chamber Hive (1861). Back of hive, showing two section-honey boxes (each composed of 8 square sections held together by coupling straps) above the brood compartment.

Dates of advances were given by Herrod-Hempsall (1930), Wedmore (1932) and Pellett (1938).

1870 G.T. Wheeler, USA, patented a tin 'separator' to insert between adjacent sections, parallel to the combs, to prevent bees building any comb thicker than the width of the wooden section.

1870s A.I. Root, USA (also in 1876, J. Lee, UK), made a 4-piece section with dovetailed joints.

1876 J. Lee, UK, made a section from a single piece of fine-grained lime wood (*Tilia*), by cutting out a V-shaped groove at three inner corners so that the wood could be bent at right angles, as in Figure 43.1b.

1876 A.J. Cook, USA, used similar fine-grained bass wood (*Tilia*) in the same way.

Figure 43.1b Recent one-pound section of honey (photo: L.L. Thorne). The top near corner is dovetailed, and the other three are bent.

What Pellett (1938) called the 'comb honey era' in the USA continued until 1906, when the Food and Drug Act prohibited adding any substance to honey that was offered for sale. This gradually restored public confidence in bottled liquid honey, which had previously sometimes been adulterated (Section 46.6).

Production of honey in sections presented several initial problems. It was necessary to prevent the queen getting into the sections, and Section 43.3 describes some of the devices used. Sections for sale had to be completely filled and capped, with no open cells, but bees disliked working in the closed-in spaces which were rather cut off from the brood nest of their colony. Only a strong crowded colony working a heavy honey flow would fill and cap all the individual cells of a comb, and such conditions were conducive to swarming. Also, bees might deposit propolis or beeswax on the wood; this was considered unsightly and had to be removed before sections were sold.

One-pound (0.45-kg) sections were about 11 x 11 x 5 cm. During the period between production and final sale, both sides of the comb needed protection against damage. At first a glazed box was used for each section, but in the 1950s this was replaced by a cheaper cardboard carton, fitted with a cellophane window which showed the comb to advantage.

From the 1970s several ingenious sections and mountings for them in the hive were devised, many of plastic materials and some round instead of square. They facilitated the beekeeper's working methods and improved the appearance of the final product, but involved a greater capital outlay. Section honey was always a specialty product, because of the constraints to its production and its fragility during transport and sale. Also in the 1970s, two alternative ways for preparing comb honey for sale were adopted, which eliminated beekeeping difficulties and the need for special equipment.

Cut-comb honey was produced in normal frames fitted with extra thin unwired foundation. These were removed when almost full and sealed, and the sealed parts cut into rectangular pieces of a size and shape that would fit into a standard transparent container with a securely fitting lid. Honey was first allowed to drain from the cut surfaces, and the pieces then put into the containers, in which the honey was sold. Honey in any remaining pieces of comb was strained and sold in jars.

Another preparation was called *chunk honey*. A piece of comb honey on thin foundation was inserted into a wide-necked transparent jar that had a secure closure, and the jar filled with light-coloured high-fructose honey which would remain liquid; this showed the comb honey to advantage.

In the USA, Killion's *Honey in the comb* (1981) described the preparation of the above types of comb honey, and beekeeping methods required to produce suitable comb.

43.2 Comb foundation, artificial comb and frame spacers

According to Edward Kretchmer (1878), his father Gottlieb in Germany produced comb foundation in 1843, by impregnating tracing cloth with beeswax and passing it between rollers which embossed the pattern of hexagonal cell bases on it. Mehring in Germany certainly made beeswax comb foundation in 1857 by carving into the surface of a wooden block a negative pattern of the hexagons. He pressed a thin sheet of beeswax between two such surfaces, suitably aligned, thus imprinting hexagons of the correct size on the beeswax sheet. When he fixed a sheet in each frame of a Prokopovich hive, the bees accepted it and 'drew out' cell walls from the ridges surrounding the cell bases. By using what was then called 'artificial' foundation or comb, in movable frames, beekeepers reduced the amount of wax the bees had to produce for comb building, and this could increase the honey yield. Also, the resultant combs were usually stronger (because of the thicker sheet of wax) and more regular, and worker cells were likely to be built over the whole area of foundation within the frame, so drone production was reduced.

Woodbury sent Charles Darwin a sample of the newly invented comb foundation some time between 1860 and 1870, and Darwin's reply is in the IBRA Library.

> I thought and still think that I wrote to thank you for the artificial comb, *which interested me much*; but if you did not get a letter, it must have been lost or I did not write it.
> With apologies, Dear Sir, and my best thanks,
> Yours very faithfully,
> C. Darwin.

Mehring's carved wooden plates were replaced by other surfaces incised with the hexagon pattern: metal or plaster of Paris or, later, plastic materials. In 1873 F. Weiss in the USA produced a continuous sheet of beeswax foundation by passing a long sheet of wax between two incised metal rollers such as those in Figure 43.2a.

Section 46.22 describes the invention and development of the honey extractor which spins uncapped combs so that the honey is flung out of the cells by

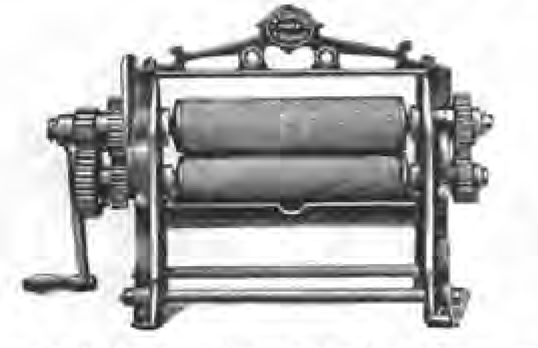


Figure 43.2a Rollers for making wax foundation (Cowan, 1908).

centrifugal force. When technical advances enabled combs to be spun more rapidly, however, the combs buckled. This trouble was prevented by embedding several lengths of fine wire in the comb foundation to strengthen it; Captain J.E. Hetherington in the USA was probably the first to do this, in 1877 (Pellett, 1938). To fix the wire in the wax, an electric current was passed through the wire to heat it.

Soon after beeswax foundation came into use, beekeepers in the USA tried to make foundation – or whole comb – of less fragile materials than beeswax. Langstroth had suggested this in 1853:

> Ingenious efforts have been made of late years to construct artificial honeycombs of porcelain, to be used for feeding bees. No one, to my knowledge, has ever attempted to imitate the delicate mechanism of the bee so closely as to construct artificial combs, for the ordinary uses of the hive; although for a long time I have entertained the idea as very desirable, and yet as barely possible.

In 1881 Samuel Wagner obtained a patent covering a wide variety of structures, and in 1870 Moses Quinby produced a comb with full-depth cells made of galvanized iron coated with beeswax. Other substances were tried: various waxes, cellophane and celluloid, cloth and hard fibres, wood veneer, paper and cardboard, metals including aluminium, tin, zinc, and wire cloth. Some products enjoyed a temporary popularity, for instance aluminium comb (Bee World, 1919 and the next few years), but none proved to be a universally adequate substitute for beeswax. A metal was too rigid and had too high a thermal conductivity; bees chewed away other materials, or did not build comb on them. The use of other waxes coated with beeswax led to much trouble later, when old comb was melted down for sale or reuse as beeswax. Johansson and Johansson (1969a, 1971) gave many more details of different foundations and combs.

Various new plastics were developed during the Second World War, and afterwards some of these were tried out. I saw an integral comb plus frame of an early plastic material in experimental use at Erlangen in Germany in 1951. K. Weiss (1983) described several successful types of plastic foundation and comb, examples of which are shown in Figure 43.2b. Ferracane (1987) published a survey of the use of plastic materials in the USA and beekeepers' assessments of them.

Frame spacers

It was necessary to place frames in each hive box at exactly the correct distance apart (Section 40.7). Initially the movable frames were positioned by eye, but this led to much irregular comb building by the bees and consequent trouble for the beekeeper, so methods were devised for automatic spacing of the frames.

Top-bars used by Prokopovich in 1814 and Dzierzon in 1848 were entirely or partly 'full width': in the hive each was in contact with a top-bar on either side, so the top-bar width determined the comb spacing. With narrower top-bars, carefully made 'spacers' were used; some incorporated protrusions from the top-bar or end-bars of each frame. Figure 40.6g includes some published by Dzierzon in 1861. Figure 43.2c(1) shows an 1874 example, and the frame in (2) had end-bars widened for two-thirds of their length, which prevented the frames rocking during transport; it was devised in 1889 by Julius Hoffman, a German beekeeper who emigrated to the USA, and has been used widely in many countries.

Alternatively a metal spacing device was attached to each lug of the frame top-bar (3 in Figure 43.2c), or to the end-bars. Herrod-Hempsall (1930) illustrated many other variants of these and other early spacers, including a castellated strip of metal attached to each end of the hive box; (4) shows a later example.

The best method for any one beekeeper depended on the type of hive he had, the scale of his beekeeping, and other factors. With strains of bees that used much propolis, and tended to stick up the area of contact between adjacent frames or spacers, devices with minimal contact were best, such as a nail or screw eye inserted in the frame end-bars.

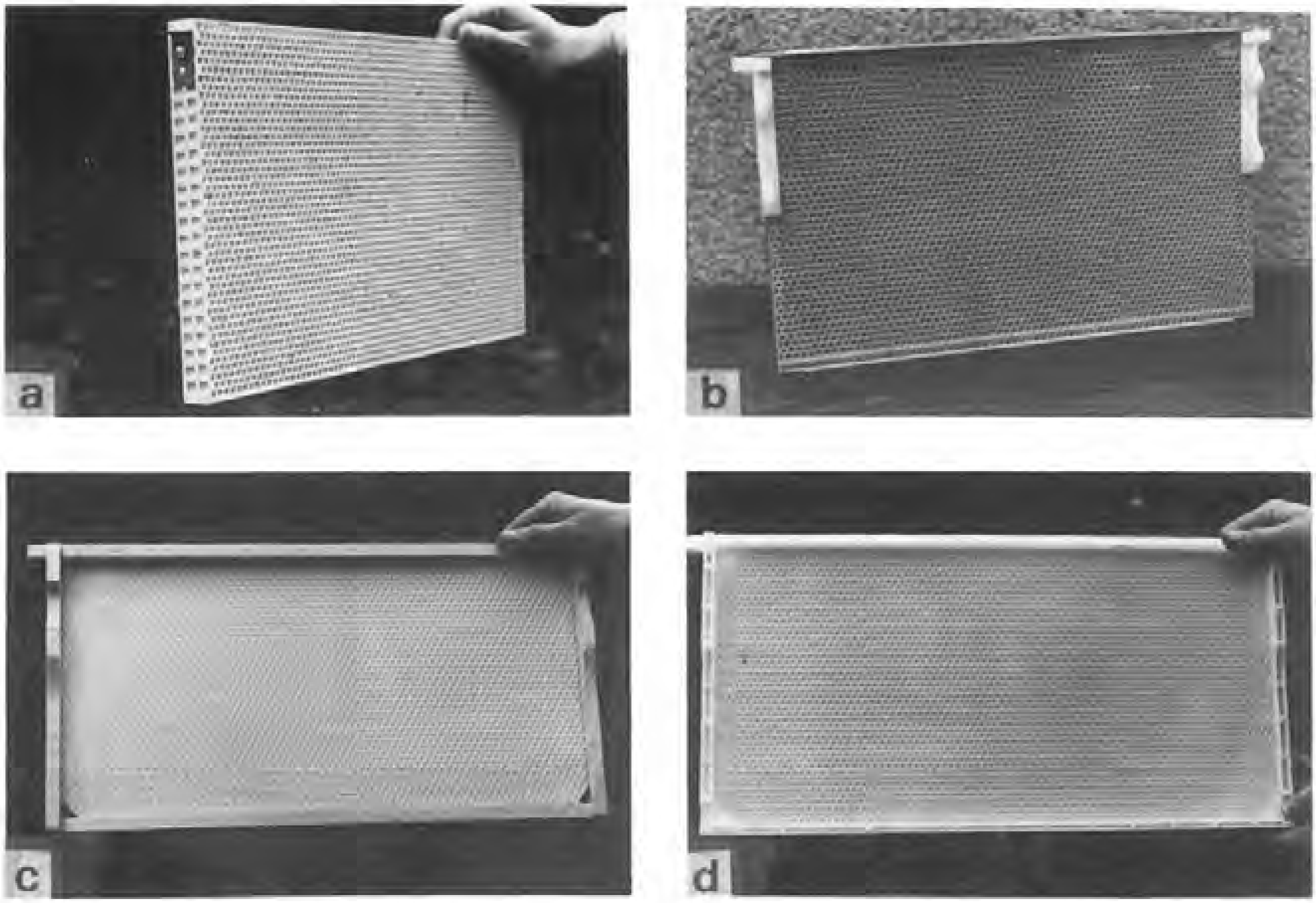


Figure 43.2b Some types of plastic comb and comb foundation (K. Weiss, 1983). (a) Rieschl plastic full-comb. (b) Schmidt plastic half-comb. (c) Arnaba foundation in a wooden frame. (d) Pierco foundation with its integral frame.

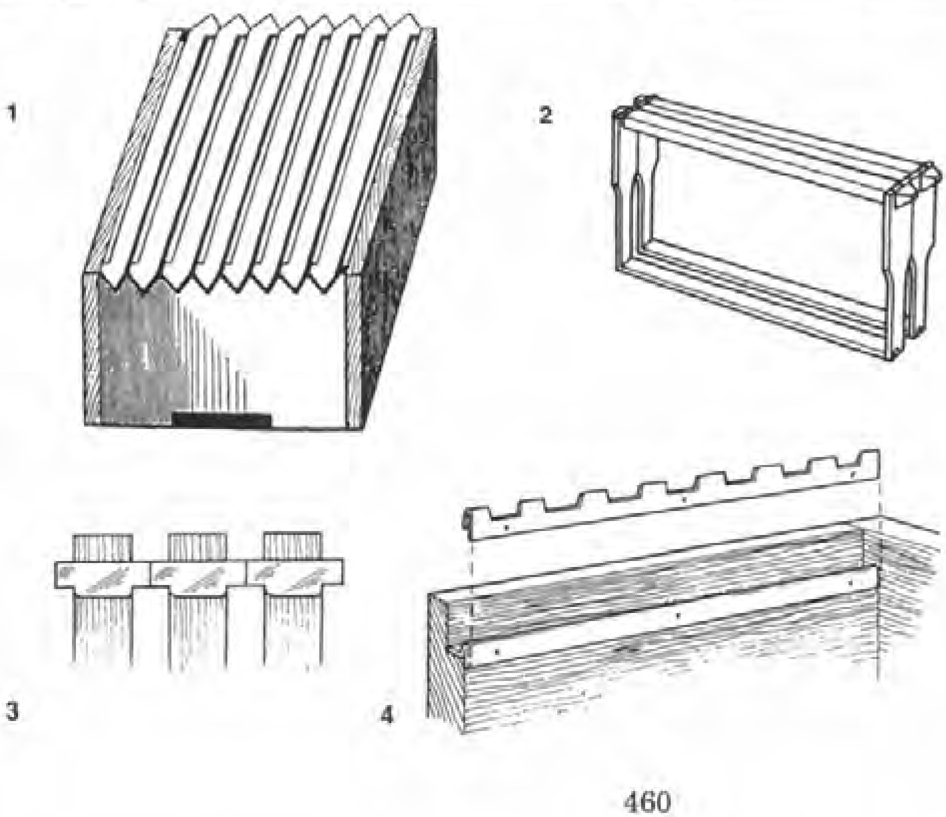


Figure 43.2c Some methods for ensuring the correct spacing of movable frames (1, Herrod-Hempsall, 1930; 2, Crane, 1990a; 3, 4, Morse & Hooper, 1985).

1 C.N. Abbott's self-spacing frames, England, 1874.
2 J. Hoffman's self-spacing frames, USA, c. 1890.
3 W.B. Carr's 'metal end', England, 1887.
4 I.A. Stoller's castellated frame-spacer, USA, 1940s.

43.3 Queen excluders

In Russia, Prokopovich made a queen excluder to place above the brood chamber of his frame hive in 1814 (Section 40.6). It was a wooden board in which he had cut parallel slots to allow workers to pass, but not the larger queen (Bilash, 1995).

Before 1851, Pettitt in England had a wooden box hive with four bell glasses for honey placed above small holes in the cover board, 'through which the *drones* cannot pass', and this would probably have excluded the queen too (Bone, 1950). In early movable-frame hives in the USA, an 'adaptor board' or 'honey board' was inserted between the two boxes, which allowed bees to pass between them only through one or more holes in the board (Mangum, 1994). In 1860 Langstroth cut one or more 6-mm slots along the edges of the board.

In France, Abbé Collin (1865 or earlier) measured the size of the smallest circular hole the bees could pass through. He quoted a diameter for drones as 5.1 mm, and for queens as 4.15 mm. He found that a worker could pass through a still smaller circular hole, but her pollen loads were then knocked off. However, a slot 4.15 x 13.2 mm long was found satisfactory, and (1875) he made the small perforated *grille à mère* shown in Figure 43.3a. It was fitted into a corresponding opening in a wooden 'honey board'. In *British Bee Journal* for 1875, Cowan reported on the use of queen excluders, and Neighbour and Sons advertised a perforated metal one. With some variations, this type of excluder was adopted everywhere, although not very quickly, and the excluder was later made as large as the cross-section of the hive. In England, a translation of part of Collin's text was published in 1877 and 1878, and his excluder was on general sale by the next year. It was not mentioned in books by Dzierzon (1878) in Germany or A.I. Root (1880) in the USA, but by 1886 it was sold widely in North America.

Bees' wings could be damaged by rough edges of perforations punched by machine in metal sheet, and Dr Tinker in Philadelphia improved the design in 1891 by making slots with rounded ends.

In 1908 in England, Arthur Wilkes patented and exhibited an excluder made of smooth rustless wires held in place by ribbed metal strips, and he sold 35,000 within seven years. In the same year A.I. Root in the USA started to make wire excluders, with a wooden frame and inner supporting strips of wood. Their rigidity made them especially useful in the USA, where the Langstroth hive box had a bee space above the frames. (In hives with a bottom bee space, as in England, the excluder rested on the frames, and rigidity was not so important.)

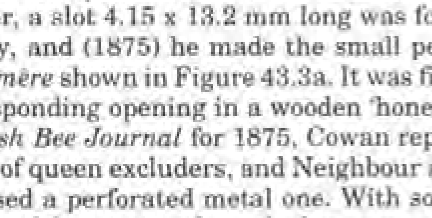


Figure 43.3a Queen excluder of mechanically perforated sheet metal (Collin, 1875). Sheet 35 x 94 mm, holes 13.2 x 4 mm.

Queen excluders were also used with skeps (Section 38.33). Bone (1950) gave other details of their history.

43.4 Removing bees from honey combs to be harvested

In the USA, Quinby's book (1879) described an easy way of removing bees from a box of honey above the brood box during a honey flow, when there would be little chance of robbing by other bees. The box was removed and placed near the hive entrance, and tapped gently a few times; all the bees then usually left it and entered the hive. In 1993 I found a similar method in western Canada, newly adopted by large-scale beekeepers.

Most other methods used during the first two decades of movable-frame beekeeping involved smoking, shaking and brushing the bees off each comb removed. Chemical and mechanical methods were then developed, both of which had successes and failures.

Chemical methods

In 1875 the Reverend George Raynor in England described how for many years he had used a 50% solution of carbolic acid (phenol) in water to clear bees off honey combs to be harvested.

> As a bee-quieter ... I have used it with success for years ... a mixture of carbolic acid and water – about half of each. One side of the carpet covering the frames is slightly raised, and a feather moistened with the mixture is passed over the top bar of each frame as it comes in view, and every bee disappears below, the degree of intimidation being as great as if smoke had been used. On closing the hive, the tops of the frames and the outside upper edges of the hive are again smeared with the diluted carbolic, when the carpet, or crown-board, is replaced without crushing a single bee. By this simple plan the opening and closing of hives

Figure 43.4a Large number of bees clustered outside a hive, as when too much repellent is used (photo: G.F. Pearcey).

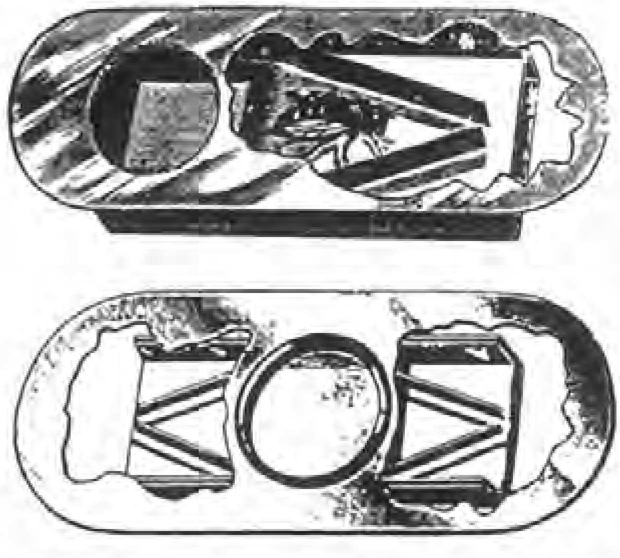


Figure 43.4b Porter bee escapes (A.I. Root, 1895; Root & Root, 1940). See text.

may be performed with scarcely any disturbance or loss of bees.

By the 1880s a piece of cloth or an absorbent board impregnated with phenol was placed over the frames at the top of a hive. Watkins (1967) told the subsequent history of the use of phenol in detail. Its effectiveness depended on the concentration, the amount applied, and the temperature – which governed the rate of vaporization. Phenol was much used in Australia where the climate is warm, but if it vaporized too rapidly it could contaminate the honey, and many bees were driven out of the hive entrance, disrupting the colony for a while (Figure 43.4a). If the phenol evaporated too slowly, as in cool weather, the bees were not cleared from the box.

In the 1960s searches were made in many countries for a chemical repellent that did not have the disadvantages of phenol (Bee World, 1968a). Substances tested in Australia, Canada and the USA included propionic anhydride, benzaldehyde (artificial oil of almonds), benzaldehyde + phenol, and butyric anhydride (Crane, 1990a). There were objections to, or difficulties with, all materials tested, and the application of any repellent carried with it the risk of contaminating the honey.

Mechanical methods

Interest therefore shifted to mechanical methods, which did not introduce any foreign material into the hive or the honey. In 1884 W.S. Pouder had made a contrivance through which a bee left the hive by pushing past a row of pins, pivoted in a way that prevented her return. Reese used small metal cones with a hole at the apex, mounted upright above the top box, and in 1890 C.H. Dibbern placed similar cones horizontally. C.C. Miller erected a pyramid of netting above a box of sections, with an outlet at the top. A.I. Root (1895) described these and other methods devised in the USA.

In 1891 E.C. Porter introduced a bee escape invented by his father: a spring mechanism which acted as a valve to allow the passage of bees only from above to below (Figure 43.4b). This 'Porter escape' was fitted into a hole made at the centre of a wooden cover board whose cross-section was the same as that of the hive; the board was inserted horizontally between the hive box to be harvested and the box immediately below. After one or two days the bees in the top box had moved down through the bee-escape, via the round hole at the top and the space between the two fine springs, and the springs prevented their return. The device failed if the delicate spring mechanism was distorted or became blocked with dead bees. Porter escapes with two outlets were in common use for many years, virtually unchanged except that from the 1950s the body was made of plastic instead of metal.

The Porter escape was unsuited to large-scale beekeeping, and in 1943 Wilbur Maguire in Canada developed a simple 'escape board' with no moving parts, which acted much more quickly (Figure 43.4c).

Figure 43.4c Example of Canadian bee escape with no moving parts, fitted to the underside of a board (photo: A.A. Clemson). See text.

A hole about 4 cm in diameter was drilled near each corner of a cover board, and a piece of wire mesh about 9 cm square was fitted on the underside at the corner, distanced from it so that bees could pass between the two. The inner corner of the mesh was cut off to enable bees to escape from the wire enclosure into the box below, and they did not return. Other types of bee escape were described by Crane (1990a).

Dienhelt (1966) was the first to describe the use of an inactive and unexceptionable substitute: a stream of compressed air to *blow* bees out of honey boxes to be harvested (Bee World, 1968a; Crane, 1990a). In a 'bee-blower', a motor – usually powered by petrol or electricity – blew a large volume of air at low pressure through a flexible tube to a wide nozzle. A honey super full of bees could be stood on one end on top of its hive, and a stream of air blown through it from the back to the front; bees evicted flew down directly to the hive entrance. By 1968 four firms in the USA were selling bee-blowers, and their use increased – especially in North America, Australia, New Zealand and Israel.

43.5 Colony management to improve productivity

Like the developments described above, early advances in the management of honey bee colonies in movable-frame hives took place in the temperate zones. The aim was to make a colony grow large as a result of early-season nectar and pollen flows, *without swarming*, and to harness the energy of the super-large colony for the storage of honey far in excess of the colony's requirements. This could give the beekeeper a very high honey yield per hive. Success depended on knowledge of colony behaviour, especially the stimuli that initiate swarm preparations.

The first effective method was developed in the USA by Demaree (1892).

> ... I transfer the combs containing brood from the brood-chamber to an upper story above the queen-excluder. One comb containing some unsealed brood and eggs is left in the brood-chamber as a start for the queen. I fill out the brood-chamber with empty combs ... But full frames of foundation, or even starters, may be used in the absence of combs.
>
> ... The queen has a new brood-nest below the excluder, while the combs of brood are in the center of the super, with the sides filled out with empty combs above the queen-excluder.
>
> In 21 days all the brood will be hatched out above the excluder, and the bees will begin to hatch in the queen's chamber below the excluder; so a continuous succession of young bees is well sustained.
>
> If my object is to take the honey with the extractor, I tier up with a surplus of extracting combs as fast as the large colony needed the room to store surplus. Usually, the combs above the excluder will be filled with honey by the time all the bees are hatched out, and no system is as sure to give one set of combs full of honey for the extractor in the very poorest seasons; and if the season is propitious, the yield will be enormous under proper management. The great economy of this system is, all the colonies will produce as nearly alike as can well be.

Later the queen moved into the upper brood box, and Demaree interchanged the two brood boxes. Dr C.L. Farrar, also in the USA, made great contributions to this type of management from 1936 onwards, and summarized his findings in 1968.

One specialized system for increasing the amount of honey produced in a hive was to use more than one queen in it, either permanently or temporarily during the summer, the queens being separated by queen excluders. In Brazil, Hannemann operated enormous colonies in the 1870s, which he made by uniting many swarms, and he obtained 730 kg of honey from the largest (Whyte, 1919). In the USA, two-queen colonies were tried unsuccessfully in the 1890s, and successfully in the 1930s by Dunham and

Figure 43.5a Hives with up to 17 hive boxes, containing exceptionally large honey-producing colonies, Canada, c. 1990 (photo: T.I. Szabo).

others, followed by Farrar (e.g. 1953). In France, Father Dugat coined the phrase *ruche gratte ciel* (skyscraper hive) in his 1945 book, which went into many editions. From the 1940s onwards, a number of trials were also made in the USSR and other countries of eastern Europe (Spoja, 1953). The operation of multiqueen colonies could give very high honey yields, but it succeeded only where honey flows were predictable and prolific, and the beekeeper's operation was dedicated and disciplined. Figure 43.5a shows a spectacular group of multiqueen hives.

The most intense nectar flows occurred in high-latitude regions with a continental climate, but after the long cold winter colonies there were often very small. So half-underground 'cellars' were sometimes used for wintering hives (Figure 41.2d), and in the late 1900s controlled-environment winter buildings (McCutcheon, 1984) enabled many beekeepers to have strong colonies in spring.

43.6 Developments described in other chapters

The USA took the lead in developing efficient large-scale beekeeping from 1851 until well into the 1900s, and many developments mentioned below were made there. Pellett (1938) described some of them in detail.

Beekeepers had used a smoker of some sort when dealing with bees for over 4000 years. The great versatility of movable-frame hives led beekeepers to want more effective smokers, especially to give a directional stream of smoke, at a volume and temperature that could be controlled (Section 34.5), and the first such smoker was produced in 1875. The materials and design of protective clothing were greatly improved after 1850 (Sections 33.61, 33.7).

The development of methods for rearing queens (Section 44.22) led to a great expansion of commercial beekeeping. The storage of large numbers of reared queens until they were required became possible much later (Section 44.23). A vital component of queen rearing and bee breeding was obtaining control of the queen's mating, by instrumental insemination or in some other way (Section 44.1). Large-scale queen rearing and, later, air transport made it possible to distribute strains of bees that gave higher honey yields, or were superior in some other way, and such bees were widely imported (Section 36.5). Large-scale queen rearing also made the package-bee industry possible (Section 44.3).

The identification of parasites and disease pathogens of bees (Section 52.7) was an essential factor in the improvement and expansion of beekeeping. This knowledge was, however, to some extent offset by the further spread of the parasites and diseases through the transport of bees carrying them (Section 36.9). A benefit of improved mechanized transport in the late 1800s was that beekeepers could increase their honey yields by migrating their hives more extensively (Section 35.4).

The most important advance in honey handling, in 1865, was the adaptation of the centrifuge used in the sugar industry to extract honey from the combs in which the bees had stored it (Section 46.22). Developments in beekeeping for pollination purposes are described in Chapter 45, and those for the production of royal jelly, bee venom, etc., in Chapter 51.

44

History of Rearing Queens and Bees for Beekeeping

The large-scale rearing of queens of selected parentage, to requeen existing colonies and to head new ones, was an important advance in movable-frame beekeeping. It also led to the production of large numbers of 'packages' of bees (each including a young mated queen) which could be transported more easily and cheaply than a colony on combs, and could be sent over very long distances.

These developments depended on an understanding of the mating process in the honey bee (Section 52.62) and an ability to ensure that queens received semen from drones of a preselected race or strain. Only a mated queen lays fertilized (female) eggs, and mating occurs in flight (Sections 4.2, 52.62). In selective bee breeding (Rinderer, 1986), control of the male parentage of the queen's female progeny is essential.

44.1 Control of the queen's mating

44.11 Confinement of a queen with drones

In the early 1700s it was still believed that mating took place in the hive. Réaumur (1740) in France enclosed a virgin queen with a drone in a 'powder glass', and also in a room with a very high ceiling, but no mating occurred. Then Huber (1792) in Switzerland established that the queen mated in flight. In the USA McLain (1888) and Davitte (1901) experimented with a flight cage, and it was reported that six queens mated in McLain's first experiment, although all other attempts failed.

In 1970 Penelope Papadopoulo in Zimbabwe used a cage 14 m high (Bee World, 1972), but no mating occurred; Schmolke (1977) described later experiments with the same cage, after two of which a queen laid fertilized eggs.

Close-up observations on the mating of a drone with a tethered queen in the air are described in Section 52.62, but such an arrangement is not practical for beekeeping purposes.

44.12 Mating apiaries

Each young virgin queen reared is placed in a small 'mating hive' with worker bees, and when a few days old she flies out from the hive to mate. An early attempt to get queens mated in free flight with specific drones, by Kolowrat in Austria in 1870. He added a hundred selected drones in each mating hive, then took the hives up a mountain well away from other hives, and fed the bees with warm syrup to encourage flight (*Bee World* 14: 91, 1933). However, mating hives were generally set up in a mating apiary which maintained one or two large colonies with many drones. From the 1880s the German-speaking Swiss Beekeepers' Association established mating apiaries in isolated areas in Alpine valleys, at least 6 km from any other colonies (Schall, 1921), and members could send their virgin queens to be mated with the drones there.

In addition to certain mountain valleys, some off-

Figure 44.1a Inspecting a drone colony in Everett Hastings's mating apiary in northern Saskatchewan, Canada, 1965 (photo: E. Crane).

shore islands could provide good sites, although winds might interfere with a queen's flight and her safe return to the hive. Figure 44.1a shows a well placed mating apiary sited beyond the northern limit of permanent apiaries in Canada.

The sex attractant pheromone in honey bees is the same for all species, and as a result of evolution the flight of queens and drones of any one species of honey bee occurs during a restricted period during the day; this separation of flight periods prevents interference by drones of one species in the mating success of other sympatric species. Using this fact, it was shown by experiments that queens would mate with drones of nearby selected colonies if queen and drone flight was prevented during the normal period (by fitting a queen excluder across hive entrances), and both queens and drones were released later (e.g. Hogg, 1991).

44.13 Artificial and instrumental insemination

Langstroth (1866) mentioned that in 1852 he applied fresh semen to unfertilized eggs a queen had laid, to try to fertilize them, and that E. Dönhoff had claimed success in doing this. A major difficulty was that the surface of the egg dried out very quickly and was then impermeable to sperm. Other methods seemed more promising.

Huber (1792) made what was probably the first attempt at artificial insemination around 1790, after Charles Bonnet suggested that he should 'try to fecundate a virgin queen artificially, by introducing within the vagina, at the end of a pencil, a little of the prolific liquid of the male'. This experiment did not succeed. In 1883 Wankler in Germany made an 'artificial penis' which he fitted into the queen's vagina. He collected semen from two drones by everting the endophallus into a small silver tube. A silver plunger operated by a lever injected the semen from the tube into the vagina of an immobilized queen, via the artificial penis (Wankler, 1927; see also Rotter, 1957). In 1885 McLain in the USA tried dropping semen from an ejaculated drone on to the 'open vulva' of an immobilized queen; he also devised and used a syringe to inject the semen. Extended experiments led to some success, for instance with 6 of 27 queens (McLain, 1887).

The general failure of these early attempts was due partly to lack of knowledge of the queen's reproductive anatomy. In 1905 Bresslau in Germany described and illustrated a valvefold in the queen's vagina, already mentioned by Leuckart in 1858, and in 1920 Bishop made further studies. But the significance of the valvefold in instrumental insemination was not yet understood.

In the USA, Jager and Howard (1914) succeeded in injecting diluted semen from a drone into the genital opening of a queen, and she laid 3000 eggs almost all of which gave rise to workers. Using a variant of this method, Howard and France (1917) managed to inseminate 1 out of 63 queens, and they 'partially' succeeded with 3 others. In 1922 queens to be inseminated were anaesthetized for the first time (Fiat, 1933).

By the 1920s instrumental insemination of farm livestock was common, and Watson (1927) developed the first satisfactory apparatus for the honey bee, which incorporated a capillary microsyringe for injecting semen into the queen's reproductive tract. Later advances were made by Nolan (1929), and by Laidlaw and Mackensen between 1936 and 1969 (see e.g. Laidlaw, 1944). Laidlaw was the first to use a device to pull back the valvefold so that it did not impede the passage of semen into the oviducts, in the 1930s. Both Mackensen and Laidlaw designed effective instruments which have been widely used, and an example is shown in Figure 44.1b. An inexpensive instrument was produced by Laidlaw and Goss (1990) to enable ordinary beekeepers to undertake instrumental insemination.

Laidlaw's history of the development of instrumental insemination (1987) included much information on earlier advances mentioned briefly here.

44.2 Queen rearing

44.21 When and how a honey bee colony rears queens

When the amount of pheromone produced by a queen is insufficient to maintain the cohesion of the bees in her colony, they rear one or more new queens (from fertilized eggs which would normally develop into workers). This situation can arise seasonally when the number of bees in the colony has become very large, and is then part of the reproductive swarming process, or alternatively if the queen is failing through age or for some other reason.

The workers rear a queen in a large, thimble-shaped cell built downwards from a comb (Figure 51.3a), and they supply it with more and richer food than that provided to worker larvae. This difference in diet is the cause of the differentiation between queen and worker.

Several young queens are reared during the

Figure 44.1b Laidlaw's apparatus for instrumental insemination of queen honey bees, c. 1960 (photo: H.H. Laidlaw). *left* The anaesthetized queen is held in a tube so that the end of her abdomen protrudes. *right* Micromanipulators, operated from left and right, open the sting chamber and vaginal orifice at the tip of the queen's abdomen, and inject drone semen from the syringe (top right).

swarming process, and shortly after the first cell is sealed the mother queen flies off with the (prime) swarm. If the colony left in the hive has enough adult bees, some of the new queens (which emerge a few days later) also fly off, each with an afterswarm. But if the colony left is small, the first queen to emerge kills the others in their cells. In either case, only one queen remains to head the colony.

In northern Europe beekeepers used small hives to encourage colonies to swarm (Section 27.11), and the colonies reared new queens.

44.22 Organizing queen rearing on a large scale

In Ancient times, beekeepers were able to organize queen rearing to some extent. In the Mediterranean region, if they fixed combs across a horizontal hive they could in principle have divided a colony into two parts so that the part without the queen would rear a new queen. Section 20.5 describes how some traditional beekeepers in Egypt still do this, and a similar procedure may well have been followed in Ancient times. Wheler's 1682 description of Greek beekeeping with top-bar hives (Section 39.12) shows that colonies were routinely divided into two, and the part without a queen would then rear a new one, provided it contained worker eggs or young larvae.

From the 1850s, beekeepers using movable-frame hives were able to develop methods for the systematic rearing of queens in large numbers, and specialized 'queen breeders' supplied young mated queens to honey producers. The first large-scale system was developed from about 1867 by Alley who described his method in 1898, and in 1889 Doolittle succeeded in rearing queens in artificial cells. The following was a successful method described in 1912 by Miller, also in the USA. An empty frame was fitted with 4 or 5 strips of comb foundation hanging from the top, each cut away to a triangular point at the bottom. This frame was put into the centre of the 'genetic colony' from which queens were to be reared (known as the breeder colony), with a frame of sealed brood on either side; frames containing honey and pollen filled the rest of the hive. After a few days, the queen had laid eggs in cells built on the foundation, and this frame was transferred to a strong colony from which the queen, and any combs containing eggs or young larvae, had been removed. This queenless 'cell-starter' colony converted some of the added cells containing eggs – especially those near the edges – into queen cells, and reared queens in them. When these cells were sealed, the beekeeper cut them away from the rest of the comb and put them into 'finishing colonies' (about 15 in each). Each cell was protected with a cage before the queen in it emerged as an adult, and the queen was finally released into a separate small queenless 'mating colony' from which she flew out to mate.

The use of four types of colony – breeder, cell-starter (or cell-builder), rearing (or finishing) and mating – has continued since Miller's time. In a later method, young larvae in worker cells of the breeder colony were transferred or 'grafted' into individual beeswax 'cups' prepared by the beekeeper to simulate the early stage of a queen cell. Before grafting, twenty of the empty cups were mounted on the underside of a horizontal wooden bar, and two or three of the bars fitted across a brood frame, as in Figure

Figure 44.2a Eva Crane watching Miel Carlota beekeepers grafting queen larvae in the shade of their truck, Morelos state, Mexico, 1957 (photo: J.J. Speck).

44.2a; also Figure 51.3b. After grafting, the frame was placed in the brood box of a cell-starter colony.

Many beekeepers in the world relied increasingly on purchased queens, for routine requeening of colonies and for genetic improvement of stock. Each mated queen was transported in a cage with a few workers, and candy as food. As early as 1863, C.J. Robinson posted queens by surface mail; later, they were sent easily and cheaply by air mail, and several million are now reared and distributed each year. Among the main producers are the USA (including Hawaii), Australia and New Zealand. Beekeepers in most countries are willing to accept queens only from certain other areas, because of the danger of introducing diseases and parasites with the queens and attendant workers.

44.23 Queen storage

Cost-effective rearing and mating of queens for sale is possible only during a limited part of the active season each year, which includes especially the swarming period. Maintaining queens over winter for sale next spring, each heading a sizeable colony, is expensive. In the 1960s, especially in eastern Europe, attempts were made to overwinter a number of separately caged queens in an incubator. In Romania Foti and his collaborators (1962) caged 40-60 workers with each queen, and in the USA Dietz *et al.* (1983) and others kept many queens, caged singly, in a queenright or queenless colony; the bees fed the queens through the mesh of the cages. A fairly high proportion died during the winter, but methods were continually improved.

Queen banks had been developed in the 1960s for transporting a number of mated queens. Figure 44.2b shows a queen bank in Australia in 1967, which held three rows of 13 individual queen cages on each side of an extra-thick brood frame. The frame was put in an expendable cardboard box, with a framed comb of honey and pollen, covered with worker bees, on either side of it. Wire gauze with holes 2 to 3 mm across covered the outer face of the cages, so that the bees could touch and feed the queens. If necessary, the purchaser who received the queen bank could leave the queens and bees in it for a few days, allowing the bees to fly out. Queen banks were developed in New Zealand (Walsh, 1967) and the USA (Harp, 1969) as well as Australia.

Figure 44.2b Gear's queen bank for transporting 78 queens, NSW, Australia, 1967 (photo: E. Crane). See text for details.

44.24 Queen introduction

If a new queen is put into a queenless colony, the bees usually kill her unless they are without any eggs or larvae which they could rear as queens. In his book on *The introduction of queen bees*, Snelgrove (1940) quoted passages which suggest that in some circumstances Roman authors could introduce a new queen successfully, probably one reared by a colony preparing to swarm. Varro said: 'The weaker bees ... are separated and placed under another King' (III,16,35), and Columella: 'When the king ... has failed ... one leader is chosen from those hives which

have several chiefs and is transferred to those which have no one to govern them, and set up as ruler' (IX.11.3)

In England, Purchas (1657) referred to the large bee variously as King, Queen, Leader, and the elder of the Blood-royal. When the queen of a swarm was lost, he 'preserved the stock by putting to them a Queen Bee taken from another'. He clipped a wing of one introduced queen, and some months later: 'I found that Commander put in by mee and no other Leader.' Réaumur (1740) carried out experiments which showed him that a new queen was readily accepted by a colony with no queen, brood or food, and Huber (1792) described how a new queen was accepted by a colony queenless for 24 hours.

A beekeeper could prevent the bees killing a new queen by placing her temporarily in a 'queen introducing cage'. The earliest description I know of such a cage is by Gélieu in Switzerland (1772), who used fixed-comb hives of either straw or wood. The cage was the size and shape of half an orange, scooped out of wood and closed at the top with a wire grid that excluded workers. A hole was made in the bottom through which a young mated queen and a few workers were introduced 'head foremost'. A long pin was inserted to close the hole, and its lower end was fitted into a hole drilled in the hive base, so that the cage was in the centre of the hive. After two days the hive was lifted up and the queen released by removing a few wires of the grid. Figure 38.3i shows a Dutch type of queen cage used in a skep.

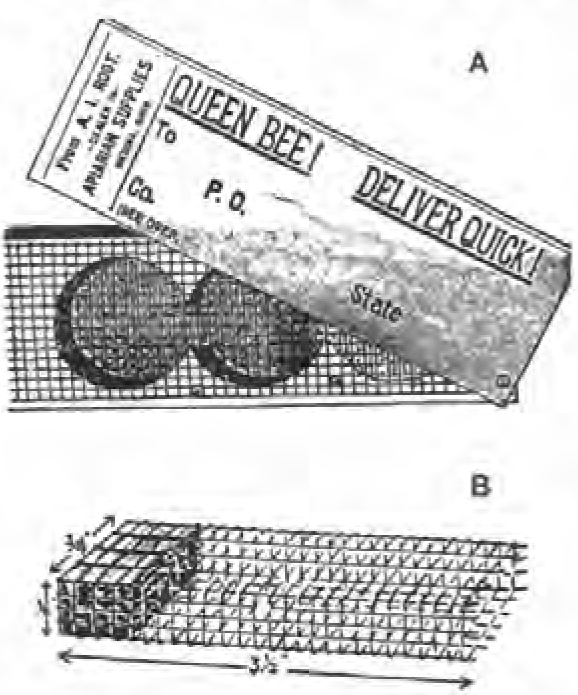


Figure 44.2c Mailing and introduction cages for queens. **A** Benton's cage, 1883 (A.I. Root, 1895). **B** Butler's wide-mesh (3-mm) introduction cage (Butler & Simpson, 1956).

In 1886 C.N. White discussed difficulties encountered in introducing queens and concluded that the use of a cage was better than any other method he described. Figure 44.2c(A) shows a cage for mailing a queen with about 20 attendant workers, which Benton had modified in 1883 so that she could be introduced in it. Before dispatch, a circular opening made in the right-hand end had been filled with candy and closed with a cork. On receipt, the cork was removed and the cage inserted in the hive; the bees in the colony gradually ate through the candy and so released the queen. This type of cage was widely used for introducing queens. But in the mid-1950s it was shown that the cage should have larger holes (3 mm square), to allow the bees of the colony to smell, touch and feed the queen, and obtain pheromone from her body (Figure 44.2c, B). The queen was inserted alone in this cage.

44.3 Package bees

In many places at high latitudes where spring comes late, colonies of bees could produce much honey in the short summer season during which there is intense plant growth, but they could not survive the long cold winters. The production and use of package bees overcame this difficulty and opened up large new areas for honey production, such as the Peace River in northern Alberta and British Columbia. The packages were produced at lower latitudes where colonies developed earlier in the year; each contained adult bees and a young mated queen, but no comb, so avoiding the transference of bee pathogens or pests transmitted on brood or comb.

A.I. Root in the USA (1878) was the first to experiment in transporting the adult bees of a colony without their combs and heavy hive. His initial aim was to reduce shipping costs when selling colonies to customers at a distance within the USA. He used a wire-screen cage such as that in Figure 44.3a, which – with the bees – weighed only 5 or 6 pounds, whereas a hive of bees weighed 45-50 pounds.

44.31 Producing packages of bees

Large numbers of packages were produced from 1913 onwards. Root and Root (1940) described their early experiences with them; Cutts (1961) and York (1975) gave other details, and Crane (1990a) summarized later developments. The first packages contained

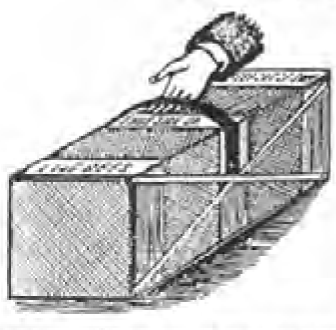


Figure 44.3a First cage for transporting a one-pound package of bees, 1881 (Root & Root, 1940).

only $\frac{1}{2}$ or 1 lb of bees (0.23 or 0.45 kg), in a box with some sides of metal mesh to allow ventilation; the box contained several slats of wood for the bees to cluster on, but these were later found to be unnecessary. At first package bees were sent by parcel post, which required the use of substantial boxes with double screening to prevent accidents from stinging.

Methods had to be worked out for providing food for the bees during transit. This was easier when a beekeeper later transported the packages in his own truck instead of using the postal service, as packages could be kept upright all the time. An inverted can (tin) of syrup with small holes in the lid proved to be satisfactory. The packages in Figure 44.3b were prepared in southern British Columbia for use in the newly exploited Peace River region.

In the northern hemisphere package bees were sold from late March to early May each year, and by 1980 well over a million packages were produced annually in the USA, for which a million queens had to be reared and mated. All the work was done to a strict timetable, imposed by the earliest dates at which the weather in different receiving regions allowed successful hiving of the bees.

New Zealand developed a package bee industry in the 1980s, and in 1986 exported 16.5 tonnes of bees in packages, mainly in April – which is autumn there but spring in the northern hemisphere.

44.32 Using package bees, and killing them

Package bees were used in two ways:

- imported (instead of colonies of bees on framed combs) into regions where more bees were needed; colonies made from these packages were kept permanently;
- imported annually into regions too far north for successful overwintering of colonies; these colonies were killed before winter.

Packages from Texas, California and south-eastern

Figure 44.3b Packages of bees prepared in Okanagan valley, BC, Canada, for transport to the Peace River, 1960s (photo: D. Kermode). The packages are kept apart by wooden slats to allow ventilation, and the bees are being sprayed with water or syrup before transport.

Figure 44.3c Installing package bees, Canada, 1960s (photographer unknown). The beekeeper is removing the can of syrup from the package; he will shake the bees into the hive below, and insert the queen cage (in his right hand) between the centre frames. After the bees are hived, they will be fed from the can of syrup on the right.

states of the USA were increasingly purchased in the Prairie provinces of Canada. For instance in Manitoba it was found in the 1920s that package bees could produce profitable honey crops, and honey production increased from about 200 tonnes in 1920 to 8000 tonnes in 1985. By this time a single beekeeper using powered lifting equipment could manage about four times as many colonies. Also, beekeeping with package bees occupied less than half the year, and during the winter months the beekeeper could undertake other work – or do beekeeping in the southern hemisphere. By the 1980s 80% of Canadian honey was produced from colonies developed each year from packages, and 350,000 packages were imported in 1984.

There were disease hazards in importing bees from the USA, initially nosema disease, and by 1987 tracheal and *Varroa* mites. Also, the arrival of Africanized bees in the USA was anticipated throughout the 1980s, and finally occurred in October 1990. In 1987 Canada closed her border with the USA to all honey bee imports, and started to obtain packages from Western Australia and queens from New Zealand.

Packages were hived (Figure 44.3c) when temperatures were high enough for bees to fly. The queen was inserted (in her cage, from which the bees would release her) between two central frames, and the colony was fed sugar syrup. Subsequently, package colonies were managed in a similar way to overwintered colonies. Moreover, they consisted of young bees and developed rapidly, and often gave higher honey yields.

As soon as the last honey flow had finished and honey supers had been removed, package colonies not to be overwintered were killed. In early years a small amount of calcium cyanide was inserted into each hive, and on exposure to air it produced hydrogen cyanide which is toxic to bees. It is also toxic to man and, in the interest of beekeepers' safety, trials were made in the 1970s and 1980s with insecticides that were relatively non-toxic to man. Carbaryl and resmethrin were used in the 1970s, but these contaminated the combs. During the 1980s phostoxin (aluminium phosphide), which leaves no lasting residue on the combs, was proposed for use in North America, and a mixture of four gases in Australia (B. White, 1987).

45

History of the Use of Bees for Crop Pollination

45.1 Knowledge of pollination in Antiquity

Some farmers in Antiquity learned empirically how to make sure of harvesting fruit from at least two crops – date and fig – by techniques which in fact ensured their pollination. Date palms (*Phoenix dactylifera*) were cultivated in Mesopotamia from 3800 BC or earlier, and Herodotus (*c.* 485-425 BC) described hand pollination in Babylon. The religious significance of this procedure was referred to by Frazer (1890) in *The golden bough* (IX.272-273).

Part of a scene in a relief found in the palace of the Assyrian King Assur-nasirpal (884-859 BC) at Nimrud (Kalhu), now in the British Museum, may or may not depict hand pollination of dates (Meeuse, 1961; also Leppik, 1977, who quoted the year as 1500 BC). Hebrew people learned about hand pollination from Egyptian and Babylonian experts (McGregor, 1976), and Meeuse stated that the practice existed in Egypt before 800 BC.

The Greek botanist Theophrastus (*c.* 373-287 BC) gave a good description of pollinating dates by hand: 'With dates it is helpful to bring the male to the female; for it is the male which causes the fruit to persist and ripen ... The process is thus performed: when the male palm is in flower, they at once cut off the spathe on which the flower is, just as it is, and shake the bloom with the flower and the dust over the fruit of the female. If this is done, the tree retains the fruit and does not shed it.' He used the terms male and female, and he also knew what was needed in practice for the pollination of the Smyrna fig, *Ficus carica*, but the context of his account shows that he did not understand plant reproduction.

It was known in Antiquity that bees from hives visited flowers, but the yellow pellets of pollen they carried on their hind legs were thought to be wax. It was not understood that honey bees pollinated flowers, although one writer noted that a honey bee went to only one kind of flower on one foraging trip: 'On each expedition the bee does not fly from a flower of one kind to a flower of another, but flies from one violet, say, to another violet, and never meddles with another flower until it has got back to the hive' (*Historia animalium* IX.40.624b).

45.2 The part played by bees in pollination, as now understood

Flowering plants and their insect pollinators evolved during the same period, the Cretaceous (Table 2.1A). During prehistory and most of the historical period, sufficient pollinating insects were generally present to pollinate crops grown by man, and with a few exceptions no special attention to the process was needed. But by the late 1800s and early 1900s a single crop (monoculture) was grown on larger plots of cultivated land, as in Figure 45.5a. Yields from certain crops proved to be unsatisfactory in some areas, and investigations showed that this was due to insufficient insect pollination. Also, some varieties of fruit were self-sterile, and a tree did not set fruit unless a tree of a compatible variety was planted nearby and insect pollinators were present to transfer the pollen.

Foraging bees effect pollination by transferring pollen grains from the anthers of one flower to the stigma of the same or another flower of the same species, as shown in Figure 45.2a. The flower's anthers which produce the pollen grains are at the outer end of stamens, a flower's male sexual organ. The anther wall opens when pollen grains have matured, and the ripe pollen is discharged: this is dehiscence. A flower's female sexual organ is the pistil, with an ovary at the base and a style arising from it which terminates in a stigma. The surface of a ripe (receptive) stigma is sticky, and pollen grains that touch it will adhere to it; the male nuclei subsequently travel through a 'pollen tube' (extruded from the pollen grain) to the ovary, where they fertilize the ovules.

In most plants a pollinating agent is needed to transfer pollen from the anther to the stigma of the same or another plant. For many plants the agent is wind, for a few it is rain, gravity or vibration, or a small animal – slug, snail, bird or mammal. But

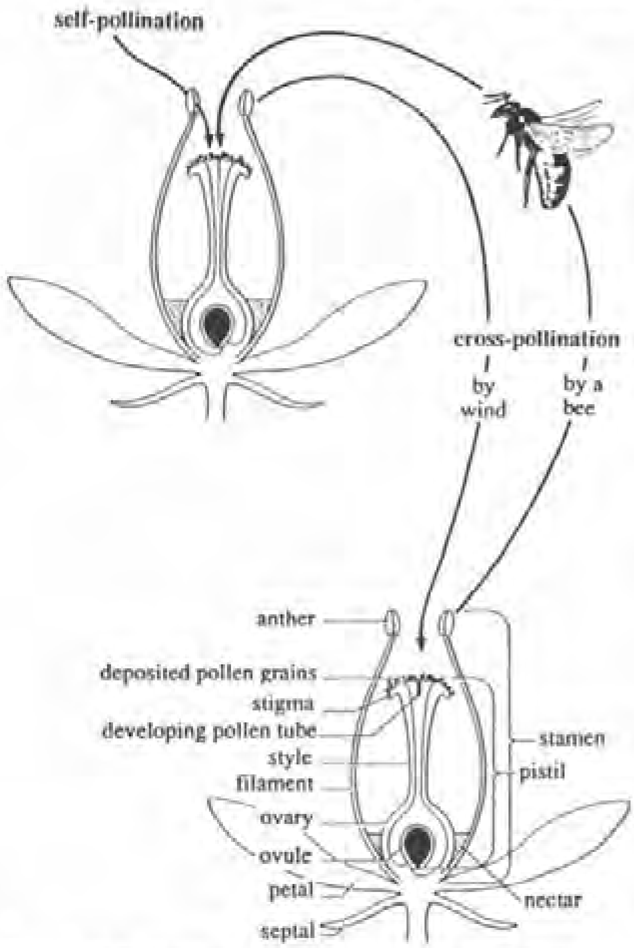


Figure 45.2a The mechanism by which a honey bee pollinates a flower (Crane, 1990a).

many of the world's plants are pollinated by insects, of which bees are the most effective because they move from one flower to another *of the same species*, not to a different species as many other insects may do. A bee foraging for nectar or pollen (Figure 45.2b) is likely to brush against the flower's anthers, and grains of pollen are transferred to her body hairs and thence to the stigma of the next flower she visits. A pollen forager is usually a more effective pollinator than a nectar forager (Free, 1993).

Although social bees have been valued for their products since early times, their greatest significance as a world resource lies in the pollination of plants. *Apis mellifera* is by far the most important managed pollinator, and is especially effective on many crops grown in monocultures. The part played by *A. mellifera* in pollinating native wild plants is more complex, especially where the bee is not native and may compete with native pollinators for food or nest sites (e.g. Matheson *et al.*, 1996).

Figure 45.2b Honey bee (*Apis mellifera*) collecting pollen from a flower of alfalfa (lucerne, *Medicago sativa*). Utah, USA (photo: W.P. Nye).

45.3 History of the growth of knowledge about bee pollination

An understanding of pollination in general, and of the part played by bees, was achieved gradually between the 1670s and 1880s. In 1676 Nehemiah Grew, an English botanist, read a paper to the Royal Society which was published as *The anatomy of plants* (1682). He quoted Thomas Millington's suggestion that the stamen of a flower 'doth serve, as the male, for the generation of the seed' and also that the pollen 'stored up' in the stamens was food for insects. Grew agreed with this and went further, stating that a plant produced seeds only if pollen reached the stigma of the flower. But he apparently assumed that the stamens shed their pollen directly on to the stigma of the same flower. In 1694 Camerarius' *Epistola de sexu plantarum*, published in Germany, described experiments in which he removed the stigmas or anthers from flowers; he found that certain plants then failed to set seed. After many more steps (see Proctor *et al.*, 1996), in 1750 Arthur Dobbs in Ireland described clearly the role of honey bees.

> From the late Improvements made by Glasses, and Experiments made, ... it is almost demon-

strable, that the *Farina* [pollen] upon the *Apices* of Flowers is the Male Seed; which entering the *Pistillum* or *Matrix* in the Flower, impregnates the *Ovum*, and makes it prolific. ... Now if the Bee is appointed by Providence to go only, at each Loading, to Flowers of the same Species, as the abundant *Farina* often covers the whole Bee, as well as what it loads upon its Legs, it carries the *Farina* from Flower to Flower, and by its walking upon the *Pistillum* and Agitation of its Wings, it contributes greatly to the *Farina*'s entering into the *Pistillum* ....

A portrait of Dobbs is reproduced in Figure 45.3a; his life and work were described by Rankin and Nelson (1990) and more briefly by Crane (1993).

In 1793 Sprengel in Germany published a book on 'the secret of Nature' revealed in the structure and fertilization of flowers (Figure 45.3b). He stressed the important part played by bees and other pollinating insects, and the significance of cross-pollination in producing heterosis (hybrid vigour). Nearly a hundred years later Darwin published his book *On the various contrivances by which orchids are fertilized by insects* (1862). From a long series of experiments, he demonstrated that seed from a cross-fertilized plant gave rise to offspring superior in growth and vigour to offspring from a self-fertilized plant, and described the experiments in his 1876 book *On the effects of cross and self fertilisation in the vegetable kingdom*. A chapter on the habits of insects in relation to the fertilization of flowers commented on the constancy of bees: 'All kinds of bees and certain other insects usually visit the flowers of the same species as long as they can, before going on to another species ... [This] is of great importance to the plant, as it favours the cross-fertilization of distinct individuals of the same species.' Brian and Crane (1959) gave further details. H. Müller's treatise on insect pollination was published in 1879; Knuth's 3-volume book on flower pollination appeared in German in 1893/96 and in English in 1906/09.

Figure 45.3a Portrait of Arthur Dobbs painted about 1752 by William Hoare, engraved by James McArdell (courtesy of Sir Richard Dobbs).

Figure 45.3b Title page of Sprengel's 1793 book. Drawings round the edge show some of the floral mechanisms Sprengel observed, including (centre bottom, XV) a bee on *Salvia*.

45.4 Use of bees for pollination in the 1800s

Bumble bees

The provision of bees to ensure crop pollination did not start in Europe or America, but in New Zealand, and the bees were bumble bees, not honey bees. Early European settlers had taken seed of red clover (*Tri-*

folium pratense) to New Zealand, but plants gave very low seed yields. Red clover flowers have a long corolla, and in England they were pollinated by bumble bees with long tongues which could reach nectar at the bottom of the corolla, but in New Zealand there were then no bumble bees. Honey bees (introduced in 1839) did not visit the flowers much (New Zealand Country Journal, 1881) because their tongue was too short to reach the nectar, and some farmers therefore wanted to introduce bumble bees. Dr F. Buckland had at least two colonies of bumble bees sent out from England in 1873,* but they were dead on arrival. Subsequent attempts failed until 1885, when overwintering mated queens of several species (see below) were transported in cool storage by ship; 45 of 282 in the *Tongariro* and 48 of 260 in the *Aorongi* arrived alive and established nests in Canterbury, South Island (Farr, 1889). The bees spread rapidly, through about 90 km a year, and nests were also sent to North Island. *Bombus ruderatus*, *B. terrestris* and probably *B. subterraneus* became established from the 1885 introductions. These are short-tongued species which usually cannot reach red clover nectar, and pollinate flowers only if they collect pollen, but Sladen (1912) reported that the 1885 introductions had led to good yields. In 1906 attempts were made to import long-tongued species, and *B. hortorum* was successfully introduced, although attempts with *B. lapidarius* and *B. ruderarius* failed. In less than ten years the bumble bees had become established throughout New Zealand, and red clover seed had realized £200,000. Thomson (1922) gave fairly full details of the whole story of the introductions, and there are more recent assessments by Macfarlane and Griffin (1985) and Donovan (1990).

Honey bees

In the USA in 1895, Waite conducted experiments to find out why a single variety of Bartlett pear (*Pyrus communis*) planted in an orchard did not set fruit. He found that it was self-sterile; a tree of another, compatible variety had to be planted nearby, and insects were needed to transfer pollen between the two. Yields of apple and other pome fruits also benefited from interplanting with compatible varieties, together with the provision of hives of bees. In 1896 Benton recommended '4 or 5 well populated hives of honey bees for every hundred large apple trees, the hives to be placed in or near the orchard'.

During the early 1900s immigrant coffee growers in various parts of Central and South America introduced hive beekeeping (Section 41.41), probably to pollinate their crop.

*The early date of the New Zealand farmers' attempt to introduce a pollinating insect – probably the first in the world – is noteworthy, since it preceded Darwin's (1876) and Müller's (1879) major works on pollination. But Darwin had stressed the importance of bumble bees in the production of red clover seed as early as 1859, in *The origin of species* (Brian & Crane, 1959).

45.5 Development of honey bee management for pollination

Movable-frame hives were well established by 1895 when Waite made his experiments, and the entire history of honey bee management for pollination relates to modern beekeeping.

For honey production, a colony is managed so that it has a large foraging population of bees to collect nectar when it is available. On the other hand a colony managed for pollinating a certain crop should have many foragers collecting pollen, which is achieved if the colony contains much unsealed brood when the crop flowers; nurse bees feeding the larvae then consume much pollen, and this stimulates foragers to collect it. Beekeepers had to learn how to prepare colonies appropriately, for instance by adding unsealed brood, and feeding with sugar syrup which also increases the proportion of pollen foragers to nectar foragers. Colonies for pollinating early flowering crops such as almond and apple had to be made larger than was normal at that season, by adding to them bees from other hives.

It was found that colonies must not be taken to the crop too early, or the bees were likely to forage on other plants already in bloom and to ignore flowers of the crop when these appeared. Hives should not be in large groups, but well spread out as in Figure 45.5a, so that the whole flowering area was visited by bees from at least one hive. The number of hives needed to pollinate different crops was learned by experience.*

At first the beekeeper might pay the grower for allowing his bees to forage on the crop, for instance with a portion of the honey obtained from the crop plant. Gradually it was realized that the grower benefited much more than the beekeeper, especially if colonies were properly prepared for pollination.

*The following story was told by Robinson *et al.* (1989). In 1905 Transient published a myth which persisted in many parts of the USA until the 1940s, that the bees' visits damaged fodder crops of alfalfa (lucerne, *Medicago sativa*) by depriving the hay of 'fattening and sweetening' elements. In 1929 Utah even passed legislation prohibiting the entry of honey bees into the state in order to minimize the numbers of these 'pests' that 'took the nectar required by the alfalfa blossoms to set seed'. Vansell and Todd (1946) dispelled the myth by showing that seed production in Utah was greatly reduced during the period of bee 'quarantine'.

Figure 45.5a Groups of hives of honey bees for pollinating alfalfa, California, USA, c. 1960 (photo: USDA).

Beekeepers in Denmark were among the first to obtain payment for taking colonies to pollinate crops, in the 1930s. By 1940 beekeepers in some other countries were also paid a hiring fee, which was increased later when the demand for colonies exceeded the supply. In some areas payment was later formalized by a contract between grower and beekeeper. The beekeeper had to supply colonies of a specified minimum strength, delivered and removed on agreed dates. The grower had to guarantee not to cause damage to the bees, by use of pesticides or in any other way, and to pay the beekeeper an agreed fee per hive.

In some circumstances, beekeepers found contract pollination more profitable than honey production. In New Zealand the number of hives provided annually for pollinating kiwifruit (*Actinidia chinensis*) grew from 1600 in 1975 to 80,000 in 1986 (Bryant, 1987). In California, about 70,000 hives of bees were hired for pollinating alfalfa in 1980 (Motter, 1981). The honey bee did not retain its importance for all crops; for instance in the USA it was largely superseded by a leaf-cutter bee for alfalfa pollination; see Section 45.62.

There was a somewhat similar sequence of events in some other countries as their agriculture advanced, but in a good many – especially in the tropics – beekeepers have not yet achieved a proper payment, or adequate safeguards, from the grower for colonies of honey bees they place on his crops.

During the 1900s more and more crops were grown in large monocultures, especially where irrigation was practised, and the number of hives required was established for many of them. Crane (1990a) listed 41 crops (especially fruits, cucurbits, nuts and rape) whose yields were likely to increase if enough hives of honey bees per hectare were provided during the flowering period, and another 24 crop plants – especially legumes – for which a similar provision of honey bees increased the yield of seed needed for propagation.

From the 1930s onwards (Burrel & King, 1932), a device known as a pollen dispenser or pollen insert was sometimes fitted at the entrance of hives in an orchard. The dispenser dusted outgoing foragers with a metered amount of pollen – or pollen diluted with an inert powder – from a selected fruit variety that would cross-pollinate flowers of trees in the orchard, usually apple or pear. Free (1970) gave details of the difficulties and successes of this technique.

The financial value of honey bees in crop production is not easy to calculate. According to an improved method used by Southwick and Southwick (1992), the value of crop yields in the USA was higher than it would have been without honey bee pollination, by an amount between 1600 and 5700 million US dollars a year.

Temperate-zone *Apis mellifera* is much more amenable to beekeeping management than other honey bees, and in any part of the world where it was kept in modern hives it could in principle be used for pollinating commercial crops. Tropical *A. mellifera* in Africa and Africanized *A. mellifera* in the Americas are in general much less amenable to management,

and their readiness to sting was a great disadvantage where people had to work on the crop during flowering. The less important contributions to crop pollination of other *Apis* species were discussed by Crane (1990b). *A. cerana* in Asia was used to some extent, but because of its smaller body size and smaller colony population it is not an effective pollinator of extensive areas of a crop. Transport of *A. dorsata* and *A. florea* colonies is difficult because they do not tolerate being fully enclosed, and their use for crop pollination is not yet exploited commercially. Bhamburkar and Peshkar (1990) described a method for moving *A. florea* colonies to crops.

45.6 Development of rearing non-*Apis* bees for pollination

Bees of different species pollinate different plants, and some bees are especially adapted to specific plant species by body size and shape or by behaviour. Since about the 1950s, methods were developed for rearing various 'promising' bee species, some of which became profitable pollinators of certain crops. The scope of 'beekeeping' has thereby been extended in economically important ways for the pollination of large monocultures of crops, both in open plots and under cover in greenhouses which lacked pollinating agents. The history of these types of beekeeping can be followed from *Apicultural Abstracts* published since 1950, and the *Proceedings* of six International Symposia on Pollination held since 1960. Some examples are given below.

45.61 Bumble bees

Bumble bees (*Bombus* spp.) are social insects, most of which live in temperate regions where colonies last only during the summer (Section 3.7); they have been hunted, and in some places even tended or kept in hives for their honey (Sections 13.2, 17.3).

Bombus ruderatus was used for pollinating red clover in New Zealand in the late 1800s (Section 45.4). From there they were taken to the Chatham Islands, unsuccessfully in 1890 and 1956 and successfully in 1976 (J. Smith, 1981); they were also sent to Chile in 1982/83 (Arretz & Macfarlane, 1986). The relative importance of native long-tongued bumble bees in the north and south of Europe was assessed by Åkerberg and Stapel (1964).

From the 1950s, methods were developed for rearing bumble bee colonies for crop pollination, in hives which were fairly simple nest boxes. Methods included the following.

- Placing suitable unoccupied hives outside in spring, when queens emerged from hibernation underground and sought nest sites in which to found their colonies.
- Capturing emerged queens when they were trying to find nest sites, putting each into a prepared hive indoors and moving it out later (bees could be handled indoors under a red light without disturbing them).
- Later in spring, finding nests already established and transferring each into a hive.

At flowering time, the hives were moved to the crop or greenhouse.

Most of the initial development of beekeeping with bumble bees for commercial pollination was done in the 1950s and 1960s in Europe and North America; see e.g. Holm (1966) and Plowright and Jay (1966). Table 45.6A lists some species used for pollination in different countries, with examples of crops. Bumble bees proved especially suitable for greenhouses in that their small colonies provided an appropriate number of bees for an enclosed space. Also, unlike honey bees, they are unable to communicate to other bees the position of (better) sources of forage, so they are less likely to leave the greenhouse through the vents, to visit flowers outside. However, a colony of bumble bees passes through a single growth cycle during each summer season, whereas growing methods were developed for producing a succession of certain fruits in greenhouses over many months, or even the whole year. A breakthrough came when Röseler (1985) in Germany discovered that if a young mated queen of *Bombus terrestris* was placed in carbon dioxide for half an hour immediately after mating, she then behaved as if she had already overwintered, and founded a colony straight away. This made continuous rearing of the species possible, and a succession of boxes containing a young colony and weighing less than 1 kg could be supplied to growers throughout the year.

Tomato flowers produce no nectar, and are auto self-pollinated when wind shakes the plants. In the past, hand-held vibrators powered by batteries had been used to dislodge the pollen, but this involved high labour costs. When a *B. terrestris* forager collects pollen from a tomato flower, she clings underneath it and vibrates her body; as a result, pollen lands on the bee and is transferred to the next flower she visits. Marks are left on each flower where a bee has gripped it, and provide a useful indicator of pollination. In the late 1980s, the requirements of continuous tomato production led to an explosion in the commercial rearing of *B. terrestris*. This was

Table 45.6A
Some species of bumble bees (*Bombus*) used for crop pollination

Country	Bombus species	Method described by	Example of crop
Canada	*perplexus*	Plowright & Jay (1966)	red clover and alfalfa (lucerne)
	rufocinctus	Plowright & Jay (1966)	red clover and alfalfa (lucerne)
	ternarius	Plowright & Jay (1966)	red clover and alfalfa (lucerne)
	terricola	Plowright & Jay (1966)	red clover and alfalfa (lucerne)
Denmark	(general)	Holm (1966)	red clover
Finland	*lapidarius*	Valle & Aaltonen (1969)	red clover
Germany	*terrestris*	Röseler (1985)	
Japan	*terrestris*	Iwasaki (1995)	tomato
Netherlands	*pascuorum*	Velthuis & Cobb (1991)	*Primula*
	terrestris	Heemert et al. (1990)	tomato
New Zealand	*hortorum*	Griffin *et al.* (1991)	
	ruderatus	Donovan & Wier (1978)	
	subterraneus	Griffin et al. (1991)	
Poland	*agrorum*	Bornus (1975); also Bilinski (1976)	red clover and alfalfa (lucerne)
	hortorum	Bornus (1975); also Bilinski (1976)	red clover and alfalfa (lucerne)
	lapidarius	Bornus (1975); also Bilinski (1976)	red clover and alfalfa (lucerne)
	ruderarius	Bornus (1975); also Bilinski (1976)	red clover and alfalfa (lucerne)
	terrestris	Bornus (1975); also Bilinski (1976)	red clover and alfalfa (lucerne)
UK	(general)	Morgan & Percival (1967)	
	(general)	Alford (1975)	
USA	*borealis*	Medler (1962)	
	mixtus	Johansen (1967)	cranberry
	rufocinctus	Medler (1962)	

probably first done by Dr R. de Jonghe in Belgium in 1985. Methods of rearing were patented and sold to a commercial firm Biobest BVBA, and other firms developed similar rearing techniques which have not been disclosed, but Heemert *et al.* (1990) gave some details of Dutch methods. By 1990 *B. terrestris* was used for pollinating some 850 ha of tomatoes under glass in Belgium and a similar area in the Netherlands. Use of these bees for pollinating tomatoes and other high-value greenhouse crops also increased in France, Denmark, Spain and the UK. *B. terrestris* from Belgium was imported into Japan from 1991 (Iwasaki, 1995).

45.62 Solitary bees

The history of rearing solitary bees for crop pollination started about 1950, in North America and Japan. Two species have so far been commercially reared and managed for pollinating alfalfa (lucerne, *Medicago sativa*), and have produced astonishing increases in seed yields. Other species were reared on a smaller scale for other specific crops; Bohart (1960) described the situation with legumes, and McGregor (1976) with crops in general.

A species of solitary bee must have the following characteristics for this type of beekeeping.

- It must rear brood successfully in an artificial nest.
- It must nest gregariously, so that large-scale rearing by the beekeeper is possible.
- It must be amenable to rearing treatments which produce a maximum adult bee population during the flowering of the crop to be pollinated.
- It must be sufficiently resistant to diseases and parasites when reared on a large scale.
- It must forage on the commercial crop in question, and pollinate it, even when other forage plants are in flower nearby.

The alkali bee Nomia melanderi

The first advances in large-scale rearing were made with this halictid bee, which nests in certain fine, well drained and sufficiently damp saline soils. The bee is native to parts of western North America where such soils occur, and in the 1940s was recognized as a very efficient pollinator of alfalfa. When a bee inserts her tongue inside the corolla of the flower she exerts pressure on the keel petal which releases

the sexual column; this action is known as tripping, and is necessary if the flower is to be pollinated. The sexual column may hit the underside of her head with some force, which perhaps partly explains why *Apis mellifera* is sometimes unwilling to forage on (and pollinate) alfalfa. *Nomia* is smaller, and in Washington state was found to trip 95% of the alfalfa flowers visited, whereas the honey bee tripped only 0.25% (Menke, 1952). The female nests in a vertical tube she digs in the soil, and over 500 females may nest in a square metre. In the mid-1950s, blocks of soil containing nests were experimentally transferred to a new site near an alfalfa field (Bohart, 1958). Stephen (1965) and others developed techniques for managing the artificial 'bee beds' so created. Soil conditions, including temperature and drainage, were maintained at optimal levels, and salts added as necessary. The bees might colonize other prepared bee beds up to 1.5 km away by migrating to them, but to establish a more distant bee bed beekeepers had to move pupae from an existing bee bed. A bee bed 250 m^2 in area was sufficient for the pollination of 30 ha of alfalfa and – provided diseases and enemies could be kept under control – very high seed yields could be obtained. A flourishing beekeeping industry with these bees grew up in parts of the USA where alfalfa was grown for seed in large irrigated plots. Bohart (1972) gave details, and Johansen *et al.* (1978) discussed problems encountered and their solutions.

The leaf-cutter bee Megachile rotundata

This is a solitary megachilid bee native to parts of Europe. The female bee cuts off pieces of leaf for lining the cells of the nest she makes in a hollow plant stem. She deposits a ball of pollen mixed with nectar in each cell, lays an egg on it, and then closes the cell. After repeating this procedure 8-12 times along the stem she departs, and when the larvae hatch out they feed on the pollen and nectar (Richards, 1984); they then leave their cells as adults, the outermost one first.

M. rotundata bees were introduced accidentally from Europe (or Turkey) to the east of North America; it is not known when or where, but they were recorded first in Virginia in 1937 (Stephen & Torchio, 1961). They then spread westward (and were also transported within North America), reaching the Pacific seaboard twenty years later. The climate there suited them, and when their populations increased the bee was seen to be a very efficient pollinator of alfalfa, so it became known as the alfalfa leaf-cutter bee. Methods for mass-rearing were developed in western USA by Stephen (1962), Bohart (1972) and others, and in western Canada – where they were first imported in 1962 – especially by Hobbs (1972) and Richards (1987).

The pupae were wintered in dry cool storage (5°, Richards, 1984). In spring, about three weeks before flowering was due, they were incubated at about 29° and 50-70% relative humidity, conditions being regulated so that adults would begin to emerge when flowering started. Trays containing late-stage pupae were taken to the alfalfa fields and housed in shelters which also contained many thousands of empty (horizontal) artificial 'stems'; these could be bundles of 4-mm straws, or blocks of grooved wooden or plastic boards as in Figure 45.6a, which shows Nye's 1964 method. After emergence, an adult female mated and then made a nest in one of the stems, lining each cell with pieces of alfalfa leaf. She foraged for pollen and

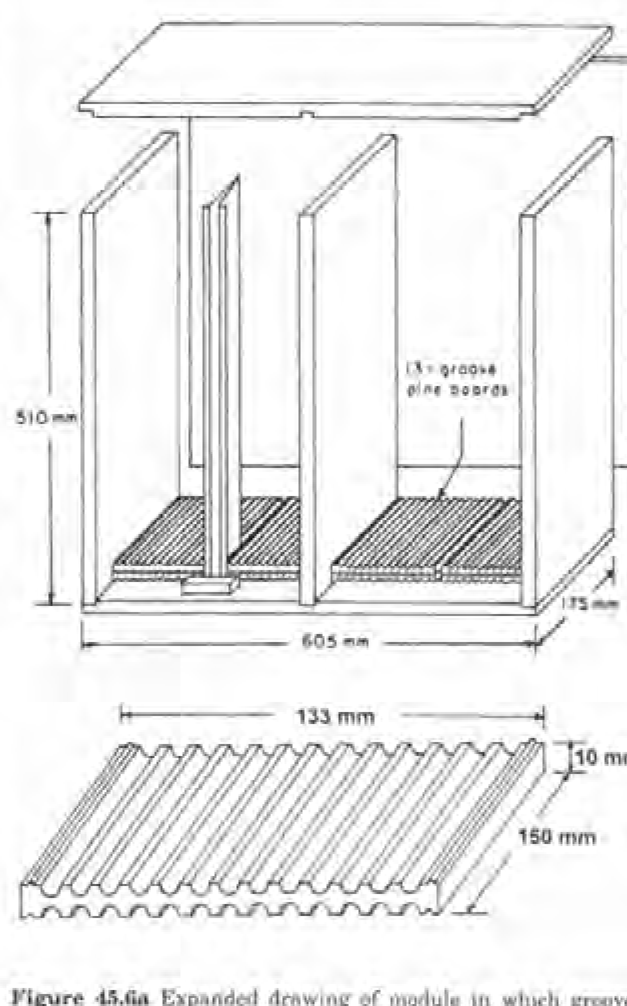


Figure 45.6a Expanded drawing of module in which grooved boards simulated hollow-stem nests of *Megachile rotundata*, Canada (drawing: K.W. Richards). One of the grooved boards is shown below; 200 of them (2600 'stems') are housed in the module.

nectar on the alfalfa flowers, which were pollinated in the process. A shelter with about 60,000 nesting females was likely to pollinate 1.2 ha of alfalfa.

Figures quoted by Richards (1987) illustrate the economic benefits from commercial rearing of *M. rotundata* for alfalfa pollination. In 1950 Canada imported almost all its seed requirements, but in 1981 – nearly twenty years after the bees were first imported – western Canada alone exported 715 tonnes of seed. By 1976, 2270 ha were used for 'pedigree seed production', and by 1981 17,000 ha. By the mid-1980s the average seed yield was 340 kg/ha in Alberta, whereas the estimated yield without the bees would be 50 kg/ha. Also, 150 to 300 million bees were exported: to the USA, Argentina, and Europe including the USSR. In 1971 *Megachile* was imported into New Zealand from Canada (Donovan, 1980), and within Canada its use was extended to other legume forage crops.

Other solitary bees

Another useful genus of megachilid bees is *Osmia*, and a number of species have been tested for possible commercial use (Crane, 1990a). *O. cornifrons* was reared in Japan from the 1950s for apple pollination (Kitamura & Maeta, 1969). In Kansas, USA, 100,000 nests of *O. lignaria propinqua* were used for apple pollination (Torchio, 1985), and full pollination of the flowers was obtained with only 600 female bees per hectare. For nesting, these *Osmia* bees preferred grooved wooden boards to tubes hollowed into styrofoam, and many nests placed close together in a shelter rather than 'stems' placed individually in trees.

Rearing methods were also worked out for *O. cornuta* and *O. rufa*. Other likely candidates for commercial rearing for pollination include some anthophorids, especially *Ceratina*, *Xylocopa*, *Peponapis* and *Xenoglossa*, the last two for cucurbits (melons, squashes, cucumbers, etc.). Crane (1990a) gave further information and references.

45.63 Stingless bees

These bees are important pollinators, especially of native plants including crops; Crane (1992) gave a list for Costa Rica. Rindfleisch (1980) made a plea for their greater use as pollinators, referring especially to South America, but there has not yet been any large-scale development. Experiments were made with macadamia in Australia (Vithanage & Ironside, 1986; Heard, 1988), and one species was used for strawberry pollination in Japan (Maeta *et al.*, 1992).

Part IX

HISTORY OF BEE PRODUCTS

Chapters 46-51

46

History of the Treatment of Honey and Beeswax, and their Trade

Sections 46.1 to 46.5 deal with the history of honey handling and trade, and Sections 46.7 and 46.8 cover beeswax. Sections 46.6 and 46.9 describe steps taken since Ancient times to ensure the purity of the two products.

46.1 Treating honey from natural nests and traditional hives

After honey combs were taken from a nest or hive, bees were removed from them by brushing, knocking or smoking. If the combs were not to be eaten whole, the honey was then extracted from them in one way or another. The simplest method was to break the combs into pieces and squeeze a few at a time in one or both hands over a receptacle; the honey flowed quite quickly out of combs still warm from the nest (Figure 46.1a). Such honey might be poured into storage containers without any straining.

A better way was to put the broken comb into a strainer, often a bag of woven cotton or other plant fibres as in Figure 46.7b, but sometimes a special pottery vessel (Figure 46.1b). The honey that dripped out, referred to as 'run honey', was the finest quality. Further honey was obtained by squeezing or pressing, but this was likely to contain pollen grains which gave a slightly bitter taste, and was kept separate. Columella in Rome (*c.* AD 50) described the method in detail.

> Whatever be the number of honey combs that are harvested, you should make the honey on the same day, while they are still warm. A wickerwork basket or a bag rather loosely woven of fine withies in the shape of an inverted cone, like that through which wine is strained, is hung up in a dark place, and then the honey combs are heaped in it one by one. But care must be taken that those parts of the

Figure 46.1a Extracting *Apis cerana* honey from combs by squeezing, Nepal, 1992 (photo: H. van Blitterswijk).

Figure 46.1b Small Polish pottery honey strainer, height 17 cm (photo: B. Wincek, Muzeum im. Jana Dzierzona MK-E-14).

waxen cells, which contain either young bees or dirty red matter [pollen?] are separated from them, for they have an ill flavour and corrupt the honey with their juice. Then, when the honey has been strained and has flowed down into the basin put underneath to catch it ... the fragments of the honey-combs, which have remained in the bag, are handled again and the juice squeezed out of them. What flows from them is honey of the second quality and is stored apart by itself by the more careful people. (IX.15.12)

Section 27.51 refers to a cloth which might possibly have been used to strain honey in Roman Britain.

Sir Jonas Moore's *England's interest* (1703) gave detailed instructions, from cutting the combs out of the hive after the bees were killed and draining them in a ridder (sieve), to bottling the various grades of honey.

In his book *The virtues of honey* (1759), John Hill recognized that honeys varied according to their plant source, but different 'kinds' of honey, to him, were those extracted differently from the comb: 'virgin Honey being such as runs out of itself ... and the common Honey such as is pressed out of the combs by violence. This is also of two kinds, some having been pressed without heat and some with: of these the former is by far the better; but both are much inferior to the pure virgin kind.' Hill regarded the best honey as that harvested in spring when 'the bees are in their full vigour'.

46.2 Treating honey from movable-frame hives

When movable-frame hives were first used in the 1850s, the comb containing honey was cut out of a frame and treated as described above. In 1865 von Hruschka succeeded in extracting honey by spinning an individual uncapped comb so that the honey from the outer side was flung out by centrifugal force, as described below. This principle has been applied ever since to the extraction of honey from combs.

46.21 Uncapping honey combs

Before spinning combs in an 'extractor', it was necessary to remove the lids (caps) with which the bees had sealed the honey in individual cells, i.e. to 'uncap' the combs. A full framed comb was held upright (or nearly so), and the cappings sliced off so that they fell away and dropped into a tray below. The frame was then turned over and the second side uncapped. Subsequent improvements included use of a special uncapping knife with a bevelled blade offset from the handle (Figure 46.2a); also heating the knife in hot water, or by steam as in Figure 46.2b or, later, by electricity. Power-driven steam knives were also devised. An alternative tool, used in German-speaking countries, was an uncapping fork which scratched away the cappings instead of slicing them off.

Figure 46.2a Bingham and Hetherington uncapping knife (Cook, 1879).

During the late 1900s a number of mechanical uncapping methods were developed. Two parallel arrays of small vibrating or revolving knives uncapped both sides of a comb simultaneously as it fell between them. The first, built by Arthur Hodgson in Ontario,

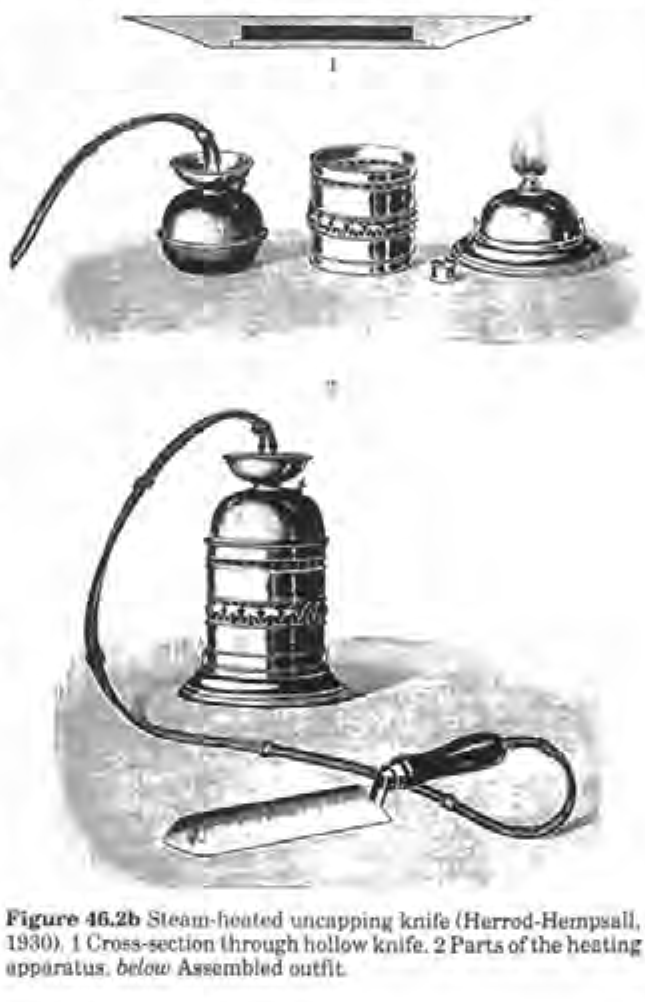


Figure 46.2b Steam-heated uncapping knife (Herrod-Hempsall, 1930). 1 Cross-section through hollow knife. 2 Parts of the heating apparatus. *below* Assembled outfit.

Figure 46.2c Demonstration model of Hruschka's first centrifugal extractor, 1865, which was in the Vienna Beekeeping Museum until 1937 (Büdel, 1963). A single framed comb was laid flat on the rectangular support, and the whole spun in a vertical plane by two operators, each of whom held one end of a stick passed through the loop at the top of the extractor.

Canada, used revolving wire brushes (Georghiou, 1955). Chains, flails and other devices were also used, and some large machines uncapped all the combs in a honey super in one operation. Townsend (1975) and Crane (1990a) gave further information.

46.22 Centrifuging honey combs

Major Franz Edler von Hruschka (who was born in Vienna) lived near Venice, where a sugar factory had recently introduced 'a centrifugal contrivance to separate liquid molasses from sugar that had already crystallized out'. Hruschka used a centrifuge in an attempt to separate liquid honey from crystallized (granulated) honey; he wanted to sell the latter as a sugar substitute, since sugar fetched a higher price than honey. This attempt came to nothing, but it gave him the idea of spinning combs to fling the honey out of them by centrifugal force. He made his earliest model (Figure 46.2c) in winter 1864/65, and demonstrated it at a beekeepers' meeting in Brno (now in the Czech Republic); it was described in *Nördlinger Bienenzeitung* 21: 236, 281-283 (1865),

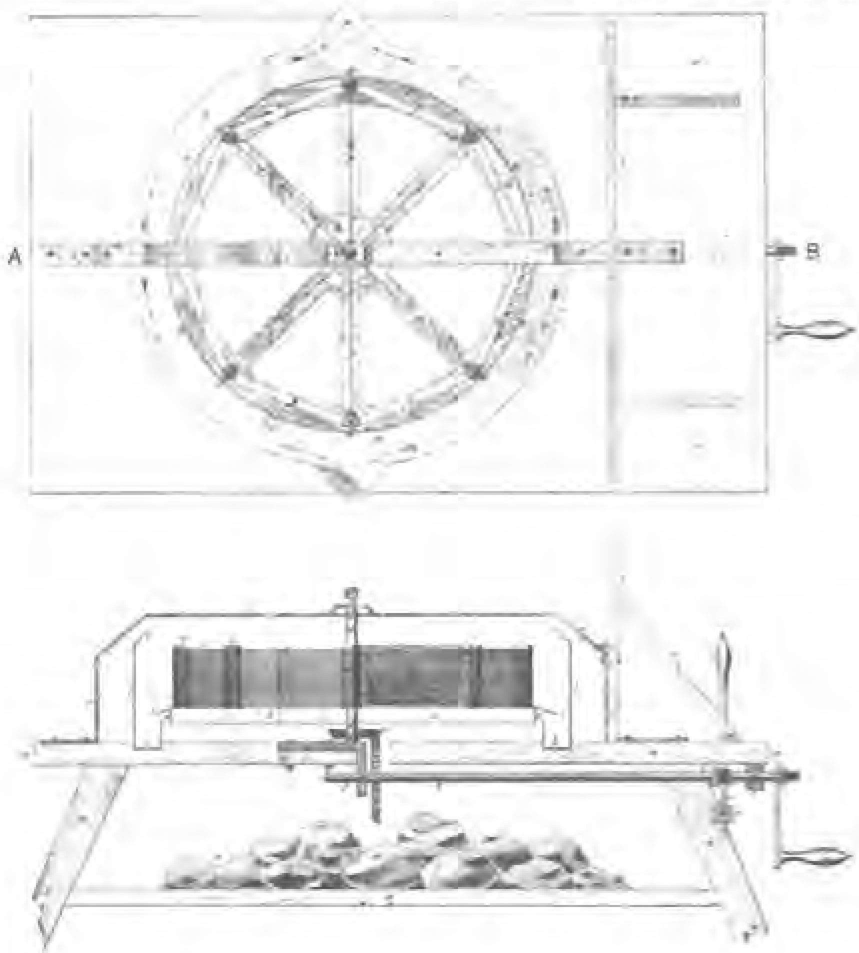


Figure 46.2d Tangential *Centrifugal-Apparat* for eight shallow combs built from top-bars (Hruschka, 1866). The diameter was nearly 4 feet Viennese measure (1.3 m). *above* Viewed from above, showing top-bars of combs (also radial struts). *below* Vertical section along the diametral plane (AB) showing base weighted with stones.

Figure 46.2e Abbott's Little Wonder extractor, England, 1875 (Cowan, 1885)

a Handle
b Pin at lower end of shaft *e*
c Wire grid of cage that supports the uncapped comb
d Bung-hole from which the cork is removed to pour out the extracted honey

and later by Armbruster (1935) and Büdel (1963). Hruschka's next model (1866, Figure 46.2d) – which set the style for later developments – was a structure in which eight shallow uncapped combs built from top-bars were arranged upright, tangentially round a vertical axis, and the whole was rotated by means of a handle. Combs were reversed in position to extract honey from the second side. In this model the gearing gave no mechanical advantage.

In England, C.N. Abbott made a cheaper 'Little Wonder' extractor holding only one frame (Figure 46.2e), and Cowan devised a self-reversing extractor

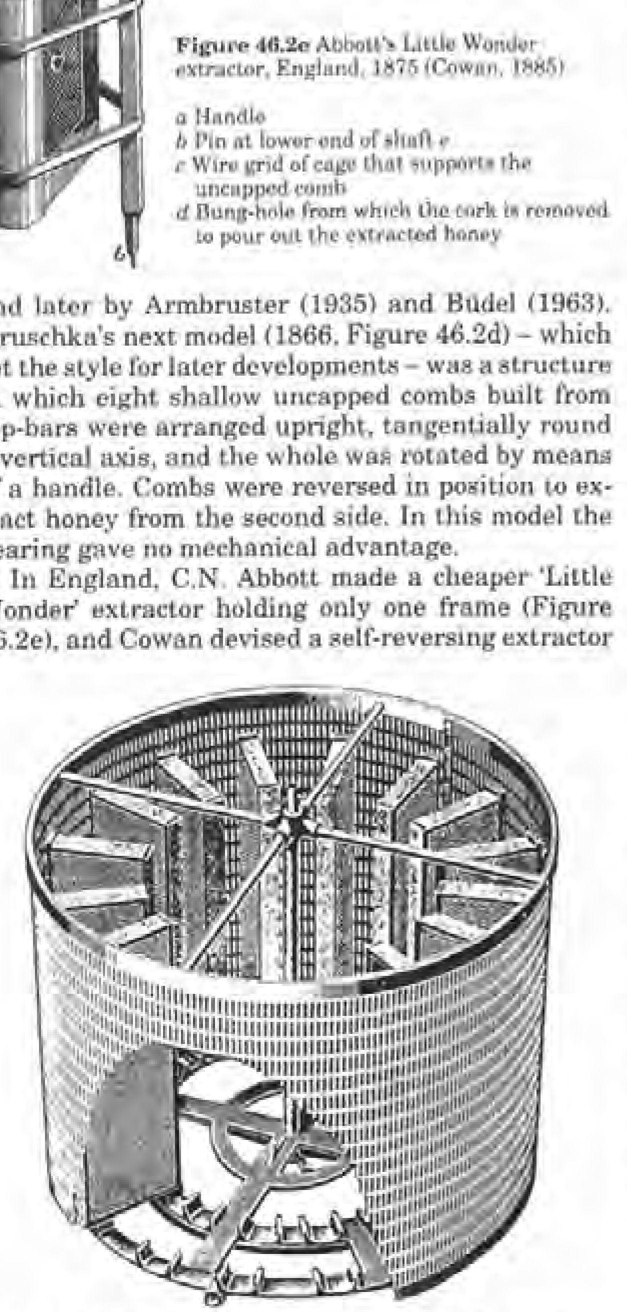


Figure 46.2f Cage of radial extractor, cut to show housing for 16 frames (Bertrand, 1951).

in 1875, described in 1881. Tangential extractors for two to eight or more framed combs became the norm by 1890 or earlier. Meanwhile, as early as 1867/68, Hamet in France mentioned an extractor in which combs were placed radially instead of tangentially, so that honey was flung out from both sides at the same time; Figure 46.2f shows a later model. Betts (1928) referred to a number of other early radial extractors. These held many more combs, but had to be run at a higher speed; they were later electrically operated as in Figure 46.2g.

Herrod-Hempsall (1937) gave a detailed illustrated account of various honey extractors, and Root and Root (1940) of some used in North America.

46.23 Handling and processing centrifuged honey

Honey was removed from the hand-held extractor by gravity through an outlet (*d* in Figure 46.2e), or was pumped out when large-scale equipment was used, as in Figure 46.2g. The next procedure was the removal of particles of wax from the honey, by straining it through cloth or wire mesh, or leaving it for several days in a tall 'settling tank'; the density of beeswax is lower than that of honey, so particles rose to the surface.

In technologically advanced countries, automated continuous-flow systems used in the food processing industry were adapted for processing and bottling honey from the 1950s. However, honey is viscous and slow-moving at low temperatures, so heating to about 35°C was necessary to enable honey to flow through the system. In-line coaxial strainers were incorporated, or a baffle tank (Townsend, 1975). The honey was subsequently flash-heated to 70°-71° or more, and then filtered under pressure through diatomaceous earth. This filtration removed minute suspended particles and air bubbles, which might otherwise serve as nuclei for future crystal formation (granulation), and honeys thus processed could remain liquid for a long period. Methods were also devised for adjusting the water content of honey. This could be reduced by leaving boxes of combs for a day or more in a warm, well ventilated room before extraction. If the water content was lower than the maximum allowed, some beekeepers increased it, after extraction, to the permitted level – for instance by blending the honey with a batch having a higher water content. Such treatments are outside the scope of this book, but were described by Townsend (1975) and Crane (1990a, 1996).

Dyce in Canada (1931) succeeded in preventing fermentation in honey by ensuring that it was finely

Figure 46.2g W.H. Turnbull's extracting plant, BC, Canada, 1930 (photo: Stocks). Uncapping equipment is behind the two hive boxes containing full honey combs. The 50-frame radial extractor on the right is powered by an electric motor mounted on the wall.

and evenly granulated before it was put into store. This was done by 'seeding' the liquid honey with a small amount of finely granulated honey from a previous batch, under specified conditions. The Dyce process was adopted in many parts of the world by honey packers with large honey-processing plants (Dyce, 1975).

46.3 Containers for honey

This Section is concerned with containers for honey during storage, use and trading; those taken to a nest or hive when collecting the honey combs are mentioned in earlier Chapters.

Containers for honey combs

Sealed honey combs might be put into almost any general-purpose container, but some were purpose-made, and a few examples spanning the past 3000 years are mentioned here. In Egypt, paintings from 1450 BC in the tombs of Rekhmire (no. 100, Figure 20.3b) and Menna (no. 69) show very similar lidded shallow dishes of fired clay for honey combs. In Kashmir in India, though not in Egypt, comb honey was still sold in similar containers in 1980 (Figure 29.5d); the lid was sealed on to the base with mud. The shallow open bowl shown in Figure 20.3d, dated to about 1350 BC, was found with a honey comb in it, in a tomb not far from Rekhmire's, and impressions of the wax cells on the surface can still be seen. Farther south in Africa, in Rwanda, a heavy black clay pot with a closely fitting lid made from banana leaves was used (Fig. 19.52/4b in Crane, 1975a).

P.T. Richards wrote a letter in 1920 describing how people in Kurdistan in northern Iraq packed honey combs for transport: 'They take a great big lump of the comb and roll it up in a fine grass mat, then they cover the whole thing in clay and let it bake in the sun. This results in a great cylinder of baked mud, but it keeps the honey in lovely condition.'

In some passages in the English Domesday Book, the word *rusca* – a wicker hive – might have indicated instead a basket containing honey combs from bees' nests (Fraser, 1958). In north-western Europe where bees were kept in straw skeps, if a cap was added for honey storage this was removed complete with sealed honey combs (Section 38.31), and could serve as a container during transport and storage. Upper boxes of early carpentered wooden hives, from Mew's in England in 1649 to the Stewarton in Scotland in

Figure 46.3a Romano-British honey pot, provenance unknown; height 12 cm, *c.* AD 150-200 (photo: E. Greenwood).

Figure 46.3b Early glass jars for 2, 1, ½ and ¼ pound of honey, USA (A.I. Root, 1895).

the 1870s, had a similar dual function (Sections 40.2, 40.6). In England in the 1750s, Chelsea sales listed porcelain honey tureens, which would have been for honey in the comb.

Small containers for liquid honey

Containers for liquid honey separated from the comb had to be watertight and, especially for long storage in a damp climate, closed to exclude air. Early examples are small wide-mouthed jars of fired clay, from New Kingdom tombs in Egypt dated to around 1500 BC; they probably had a cover sealed on with mud or wax. A Romano-British honey jar (Figure 46.3a) survives from AD 150-200, and substantially similar ones were still used for honey in Spain in 1961 (Crane, 1975c).

An empty gourd was widely used as a container for liquids, including honey. In the gardening section of *De re rustica* (Book X.386), Columella mentioned a gourd:

> Which makes a vessel for Narycian pitch
> Or Attic honey from Hymettus' mount.

English examples of ornamental honey pots made for table use between 1750 and 1850 were described by Hughes (1973); they were of porcelain, earthenware or pressed glass, or silver or other metal with a glass lining, and most were in the shape of a coiled-straw skep. After the centrifugal honey extractor came into use in the 1860s (Section 46.22), glass jars with a screw-top lid were available, and were commonly used for honey. Early jars were rather slender, showing liquid honey to advantage (Figure 46.3b), but more squat jars were used later, from which all the honey could be taken out with a teaspoon. In many countries a standard glass jar was manufactured that held 500 g or 1 lb and, as glass production methods improved, the jars became much lighter in weight. In the late 1900s opaque plastic pots superseded glass jars for granulated honey, whose appearance was not its main selling point, and many novelty containers were also produced.

Large containers for liquid honey

Figures 20.3a and 20.3b show types of large honey storage jar of fired clay used in Ancient Egypt. A large Roman honey jar was a *cadus* (also a wine jar) or an *urceus* (jug or pitcher). A number of *amphorae* (two-handled jars as used for wine) dated to between 400 and 200 BC were found in the Black Sea region,

Figure 46.3c Display of Roman *amphorae* used for transporting honey (Constanta Museum, Romania).

and some in Figure 46.3c were marked with a bee, showing that they were containers for honey (Constantinescu, 1996). Others were found in wrecks in the Mediterranean, especially off the Turkish coast near Halikarnassos, now Bodrum (Theile, 1964).

Alamūt, built about AD 860, was one of the strongest fortresses of the Persian Isma'ilis (Assasins) in the Elburz Mountains about 100 km north-west of Tehran. It contained large tanks hewn out of the rock for storing liquids, including honey. In the 1250s Ala-ad-Din Juvaini related that when Alamūt capitulated to the Mongols in 1256, the stores in the tanks were pillaged, and 'a man waded in the honey tank without realizing how deep it was, and before he was aware he was immersed in the honey like Jonah'. He, too, would have drowned 'had not favour from the Lord reached him' (*Koran* 68.49); see Boyle (1958).

Some primitive peoples did not have fired pottery, and put liquids in tightly woven baskets. Guayaki in Paraguay carried their store of honey from camp to camp in special egg-shaped baskets of plaited sedge, holding 8 kg or more (Vellard, 1939); these were made watertight by a lining of wax which, like the honey, came from stingless bees.

In northern Europe large quantities of honey were sometimes stored in wooden vessels. Three types mentioned in Ireland in the 1100s were probably of wood (Charles-Edwards & Kelly, 1983, p. 53); when full of honey, the smallest could be raised over a man's head, the middle one up to his breast, and the largest only up to his waist.

Fraser (1958) quoted several English references between 1200 and 1500 to barrels of honey. In mediaeval Russia and up to the 1600s, tubs called *kadi* were used for honey sold on the market and for mead served at feasts (Galton, 1971).

46.4 Trade and other transfers of honey

Honey was given away, sometimes as a prestigious gift; it was bequeathed, handed over as a due, tax, tithe or rent, bartered for other goods and, later, sold for money. A closed container was needed for transporting liquid honey.

46.41 Gifts and bequests

Harvested honey was often shared among family or close group members, and from Ancient times honey was also presented on special occasions. In early Hindu mythology, the laws of Manu instructed a householder to offer a honey mixture *madhuparka* to certain visitors of importance (Ransome, 1937). Breasted (1962) quoted examples from Ancient Egypt. Sebni was Governor of South Egypt around 2000 BC, and an inscription at Aswan records his words: '[I took] a troop of my estate, and one hundred asses with me, bearing ointment, honey, oil ..., to make presents [in] these countries of the negroes' (Vol. I, §366). Ineni, a retired official of Tuthmosis II (1483-1449 BC), was supplied with various foods from the table of the King, including honey: 'as His Majesty himself said, for love of me' (II, §117).

Around perhaps 1700 BC, when Egypt was already producing much honey, it was said that Jacob sent his sons with gifts to their brother Joseph who was a high official under the Pharaoh: 'Take in your baggage, as a gift for the man, some of the produce for which our country is famous: a little balsam, a little honey ...' (Genesis 43.11, NEB). A metaphor that illustrates the high esteem in which honey was held by the Israelites survives from about 600 BC: 'You [Jerusalem] had flour and honey and olive oil for food, and you grew very beautiful, you grew into a queen' (Ezekiel 16.13, NEB). In Theangela (now

Etrim near Bodrum) in Asia Minor during the 300s BC, it was the practice to present two jars of honey to distinguished foreigners honoured by the state (Crane & Graham, 1985).

In China, in the AD 500s the Emperor gave one of his officials a quart of honey as his 'drug of longevity' a month after his retirement (Kellogg, 1968). In 1233 a high official 'presented 300 rolls of satin with linings, as well as roebuck meat, tea, honey and other commodities' to the Emperor, who bestowed on him a title and a golden tablet (Hok-Lam Chan, 1993).

Honey was sometimes presented to monasteries in Christian countries; for instance in 965 the town archives of Berlin recorded that Otto I gave the monastery at Magdeburg a tenth of all honey collected in a number of districts (Berner, 1920). But beeswax, which monasteries needed for candles, was a much more common gift (Section 46.81).

46.42 Payment of dues and taxes

Examples below from four continents show that various kinds of dues were paid in honey, from the Ancient World onwards.

A marriage contract in Ancient Egypt ran: 'I take thee to wife ... and promise to deliver to thee yearly twelve jars of honey' (Glock, 1891). Around 1000 BC in Ancient India, the laws of Manu regulated the amount of honey a king might claim from his subjects as a sixth of the production (Ransome, 1937). From Ptolemaic to Byzantine times (200 BC to AD 300s), Egyptian beekeepers paid taxes on hives in honey and wax, or sometimes in coin (Crane & Graham, 1985). In Ethiopia it was customary to pay some taxes and land rents in honey (Fichtl, 1995a).

A text probably written in the late 800s set out obligatory and voluntary tithes of honey in a region near Mecca in the Arabian peninsula (Hitti, 1966). Persons who owned honey (hives?) had to 'contribute to us what they used to contribute to the Prophet, i.e. one vase in ten'. It was an obligatory payment with the implication that the valleys of those who did not comply 'would not be protected', but no dues were payable on honey produced on land already subject to land tax. In 1989 an Afghan refugee beekeeper, a devout Muslim, told me in Peshawar how his beekeeping had prospered, so that he now had more than three hundred hives; his face lit up as he finished: 'Each year I give one tenth of my honey to the *mujahidin*.'

Records from Europe are more numerous. After Muslim Arabs conquered the Spanish in 711, a list of dues payable in Murcia included honey, and slaves paid half as much as others (Monferrer, 1991). Around the same period, in Ireland the owner of bees which stung a person had to give him 'a man's full meal of honey', and in England under the law of King Ide of Wessex the annual rent on 10 hides of land included 10 vats of honey; one hide was the area that would support a free family and dependents. Charlemagne was both King of the Franks and Roman Emperor from 800 to 814, and his *Capitulaire de Villis* (799) – which applied to all lands under him – referred to dues paid in honey, wax and mead (§44 and §62, Guérard, 1853). In Poland, serfs in the San Valley who had bees in the usual upright log hives paid dues in liquid honey, but those with horizontal log hives had to pay in comb honey (Wolski, 1960).

In England between 1066 and 1075, a writ was issued against Wuduman in Somerset, Keeper of Queen Edith's horses, who: 'for 6 years has withheld her rent in honey and cash'. The Domesday book, compiled during the hundred years following 1087, contained many references to dues paid in honey, but none to dues paid in wax, which suggested to Fraser (1958) that the dues were of pre-Christian origin, since the Church required wax rather than honey. In 1237 the rent paid by Matildis widow of Jordan, on rather less than two acres (1 ha) of land in Crondall, Hampshire, included 4½ stoups of honey; other Crondall rents included amounts of honey from 1½ to 63 stoups a year (Baigent, 1891); the size of the stoup referred to is not known. In mediaeval Wales, honey rents were also quite common.

Local historians in England who searched through unpublished records located some of the above entries, and others about honey tithes paid to the church, in Wessex in 987, Yorkshire in 1582 and 1716, and Hertfordshire in 1593. Monks at St Augustine's Abbey in Canterbury, founded in 598, were noted for their stringency in extracting tithes, and they wrote in their Black Book that 'honey must also be tithed'. Bederke (1980) recorded that, around 1200, peasants in Schleswig-Holstein had to pay a tithe of their beekeeping yields to the church. Figure 26.2b, from Saxony in the late 1300s, shows a tithe being paid in hives.

Tolls might be charged for taking honey into a town or across a bridge. For instance in 1080-1082, monks of St Aubin in Angers, France, exacted tolls on commodities peddled by peasants in neighbouring markets. Tolls were payable for certain commodities carried on the neck, including: feathers (1 denier); wax (honeycomb a halfpenny); a hive (a halfpenny); a bed with bedding (1 denier); a wedding outfit (4 deniers). Tolls were also charged on honey and beeswax at Bran in Romania. In England, charters of 1285 and 1412 listed portage (toll) charges on honey

crossing Montford Bridge over the Severn in Shropshire according to the number of tuns, carts or jars. The lowest charge was 1d. (in 1412), and the highest was 4d. (in 1285); 3d. was charged for a horse load (Drinkwater, 1907).

In Mesoamerica, the Maya and Aztec exacted dues of honey from peoples they conquered, and *Codex Mendoza* included a list of tributes sent to the Mexican Emperor Montezuma in the 1400s: towns sent 100, 200 or 300 jars of honey annually (Ransome, 1937). Section 30.3 provides other examples.

46.43 Barter and trade before 1853

Trade in honey must have existed early in India, since by about 1000 BC Brahmans – members of the highest caste – were forbidden to sell or trade in honey and wax. A tax was imposed on honey in the Khasa Kingdom in Nepal (1000-360 BC). In China, one prince sent honey to another in the 300s BC, in return for a piece of land. In the first century AD honey was a main import into China from the west, and silks were bartered for it (Appendix 1).

Honey was traded within and between Ancient civilizations in the eastern Mediterranean region and in Mesopotamia, and Monferrer (1995) quoted a number of records. Trade in honey was referred to on Linear B tablets from Mycenean sites (Section 23.11). About 500 BC in the Aegean island of Andros, there was legislation on the export of honey and beeswax excess to requirements (Y. Rerras; see Nikiti, 1996). Around 400 BC in Greece, Aristophanes mentioned *melitopoles*, the honey merchant. A letter in Zenon's correspondence written in 259 BC listed imports of honey into Egypt from Rhodes and Athens, also from Theangela, Lycia and Korakesion in Cilicia – all in Asia Minor – and Chalybon in Syria (Roberts, 1936). According to Strabo in Roman times, large quantities of honey were exported, for instance from Turdetania in southern Spain (III.2.6), and Ligurian people on the north-west coast of Italy carried their honey to Genoa (IV.6.2); also 'inhabitants of the Carnic Alps exchange wax, honey and other natural products for necessities of life' (IV.6.9). By the 900s, honey and beeswax were taken from Russia along a trade route via the Neva and Volga to the Caspian Sea and thence to Asia (Gunda, 1968). However, in 1555 Olaus Magnus reported that although Europe then exported much wax, 'honey they reserve to themselves in great supply'. Arabs were important in the honey and sugar trades in Spain during the Muslim period, and there were still Arab traders in Granada in the 1500s who specialized in buying honey from beekeepers and selling it to merchants for the retail trade (Monferrer, 1991). A small book in the Valencia dialect described how to measure honey.

Honey was traded in large quantities in Persia. The Annals of the Early Caliphate from 632 to 680 (Muir, 1968) recorded that in AD 642, when Sasanid Persians under Pērōzān (Arabic Firuzān) were retreating from a victorious army of Muslim Arabs:

> the fate of the Captain-general, Firuzān, became proverbial. Flying towards Hamadan, he was stopped in a mountain pass choked by a caravan laden with honey. In seeking to turn the pass, he lost his way, was overtaken and slain. Hence the saying, 'Part of the Lord's host is the honey-bee'.

(Hamadan, the ancient capital of Media, was some 250 km south-west of Tehran.) Honey was taken from Buthai province to Japan around 800 (Hämäläinen, 1975).

Man'kov (1951) listed amounts of honey purchased by five Russian monasteries between 1569 and 1599; the average was several tonnes annually per monastery.

Records survive of some of the exports and imports of honey within Europe throughout the Middle Ages and subsequent periods. For instance in the period after AD 989, an Irish ship partly laden with honey sailed to South Wales, and at marts set up on the Welsh coast: 'Norse merchants maintained a brisk trade in Welsh slaves, horses, honey, malt and wheat, in exchange for Irish [or Irish-imported] wines, furs, ... butter and coarse woollen cloth' (Crane, 1975a). The preamble to a 1580 Act of Queen Elizabeth of England included the passage:

> By the goodness of God this Land doth yield great plentie of Honye and Waxe, as not onlye dothe suffice the necessarye uses of the Queenes Majestie and her Subjects to be spent within the Realme, but also a great quantitie to be spared to be transported unto other Realmes and Countreys beyonde the Seas by waye of Merchaundize, to the great Benefite of her Majestie and the Realme.

In some parts of Europe beekeeping was almost destroyed during the Thirty Years' War (1618-1648), but a 1658 record quoted by Bederke (1980) lists a quarter of a tonne of honey among supplies ordered by General Czernike in Schleswig.

The Maya people of Yucatan and other parts of

Mesoamerica were trading in the honey of their stingless bees by the 900s.

Honey prices

In the Hittite Kingdom (1500 BC, Section 21.2), honey fetched about the same price as butter, and this was true in many regions in later periods. Table 46.5A gives some indication of the increase in the price of honey in England since 1250. Galton (1971) quoted honey prices in Russia from the Middle Ages onwards, for instance in the 1500s in Novgorod, Volokolamsk and Moscow, and in the 1600s in Moscow. Prices have also been published: for France, 1201-1800 (Avenal, quoted by Deerr, 1949); German towns, 1493-1732 (Wendorff, 1963); Russian towns, 1548-1597 (Galton, 1971); the Rhone valley in Switzerland, 1578-1586 (Bindley, 1967). The German prices showed the effects of the Thirty Years' War; in 1622 especially there seems to have been a honey famine everywhere, and prices were $2\frac{1}{2}$-8 times those in 1621.

46.44 International trade from 1853

International trade in honey increased through the centuries as shipping became faster and easier (see e.g. Section 36.13) and as new beekeeping regions of the world produced honey cheaply. Both production and international trade increased further after movable-frame hives came into use in 1853 (Section 41.8). Few figures are available for worldwide exports or imports until the 1950s, but Cowan (1928) published some earlier annual imports into Britain.

	1891 to 1903, range
Chile	180-587 tonnes
British West Indies	62-578
Spanish West Indies	171-369 (1891/93 only)
USA	161-406
Australasia	0-180
France	45-82
Canada	2-59 (1896/1903 only)

There was a consistent increase in imports from BWI, and a decrease in those from the USA.

		1915 to 1921, maximum
1917	Chile	1645 tonnes
	France	165
1918	USA	7148
	Cuba	1787
	other countries	1507
1920	Dutch West Indies	304

In the Americas south of the USA, hive beekeeping in many regions did not start until the late 1800s (Section 41.4), but two countries became outstanding honey producers in the 1900s. Argentina started to export in the 1930s, and may have been the world's largest exporter in the 1950s (12,500 tonnes in 1954). Mexico, which also began to sell honey abroad in the 1930s, exported more than any other country in 1960; it was then overtaken by China, which has dominated the world market in honey ever since.

Exports in 1993:	
China	97,000 tonnes
Argentina	55,000 tonnes
Mexico	35,000 tonnes

Each of these countries has at least one region in the subtropics where the honey season lasts for much of the year, and the bees suffer from neither a long cold winter nor a long hot dry season.

The chief honey importers were European countries with a large population accustomed to eating honey, and also a relatively low honey productivity per hive. Imports into Germany were the largest, and these increased substantially from the 1950s until they reached nearly 81,000 tonnes in 1993.

Morse and Nowogrodzki (1983) published available statistics for USA honey production, trade and prices: a few between 1830 and 1929, and more in later years. The USA, and Canada from the 1930s or earlier, both imported honey and exported their own. The USA was a net exporter until the 1940s, when its imports started to overtake exports. On the other hand Canada's more modest exports grew after the 1960s because its honey production increased greatly; Section 41.2 explains the background to these changes. Japan became a honey-consuming country after 1960 – as a result of influence from the USA occupation from 1945 to 1952 – and by 1990 it was importing more honey than any country except Germany.

46.5 The importance of honey in relation to other sweeteners

Honey was the sweet food most universally available, although some other sweeteners were obtained from plants that grew locally. Maltose, a sugar for which a Chinese word existed from the Chou dynasty (c. 1027-256 BC), was made by soaking wheat or rice grains in water and cooking them after fermentation. Farther south in Asia, water was evaporated from the sap of sugar palm (*Arenga pinnata*) and some

other palms. In parts of northern North America, maple syrup was produced by tapping sugar maple trees (*Acer saccharum*) in spring and evaporating water from the sap in open pans; some native peoples used the less productive birch (*Betula papyrifera*) similarly. Morus (1954) noted that the shift from honey to sugars obtained directly from plants is the earliest known substitution of an animal product by a plant product.

Honey retained its primary position until it was superseded by sugar obtained from the sugar cane (*Saccharum officinarum*), which originated in India. Nearchus, Alexander the Great's admiral, brought news of the reed which 'gives honey without bees' when he returned from India in 326-325 BC. This sugar was said to be used in China by 200 BC; Arabs knew and prized it from the AD 700s, and they introduced its cultivation in Sicily, Cyprus, Morocco and Spain. Sugar was hardly known in northern Europe until the 900s and 1000s, and for the next few centuries it was rare and expensive, and was treated as a spice, condiment or medicine; at first eating it in more than very small amounts was considered dangerous. After the 1100s returning Crusaders brought more knowledge of uses of sugar, and it became a fashionable expensive ingredient in cooking (Leeming, 1981).

From the late 1600s to the early 1800s, commercial growing of sugar cane was developed on a large scale in Caribbean islands, using continuous supplies of slaves from Africa to work the plantations. In Europe, production of sugar from sweet varieties of the beet *Beta vulgaris* was explored between the mid-1700s and early 1800s, and subsequently became important; by 1848 Russia had over 300 sugar beet factories. The final column of Table 46.5A gives the combined world production of sucrose from sugar cane and beet. Baxa and Bruhns (1967) published a full account of the great expansion of the sugar industry after 1900. World production probably increased more than 20-fold between 1850 and 1950.

Table 46.5A shows how the competition between sugar and honey progressed over the centuries in England. The prices per pound (0.45 kg) of honey and sugar are taken from various documents written since 1250. The relation between the two prices (column 4) was not affected by the inflation which occurred during several periods, but whereas in 1250 honey cost around one-fiftieth as much as sugar, in 1987 it cost nearly seven times as much as sugar. Sugar was not in common use until well into the 1700s, although in 1633 James Hart said that 'sugar hath now succeeded honey' (Raylor, 1992). The two

Table 46.5
Chronology of the displacement of honey by cane/beet sugar in England

A Based on Crane (1990a), Raylor (1992) and unpublished records. 1 (new) p = 2.4 (old) d.

Year	Price in England, (old) pence per lb			UK sugar consumption	World sugar production
	honey	*sugar*	*honey ÷ sugar*	*per person (kg)*	*(million tonnes)*
1250	0.43	19	2%		
1350	0.57	20	3%		
1410	1.17	24	5%		
1460	1.13	14.3	8%		
1480	1.23	8.7	14%	(estimate: 2 or less)	below 1.5
1530	1.64	6.8	24%		
1575	3.4	18	19%		
c.1600	2.3-5.7	13-20	24%		
1705		10		2	
1719	3.4	5	68%		
1750	3.87	6	63%	2	
c.1800	6	10	60%		
probably between 1800 and 1850			100%		
1850	15	4	375%	14	1.5
1890/95	8.5	1.8	470%	32	5+
1900				38	11+
1930	26	3.5	740%	41	
1950				36	35
1965	70	10	c. 700%	50	68
1984					99
1987	360 (150p)	53 (22p)	680%	39	

prices probably reached parity between 1800 and 1850. Fewer data have been found for other countries. In France honey cost on average 13% as much as sugar in 1626/50, and 59% in 1651/75 (Crane, 1975c). In northern Italy honey was still less expensive than sugar in the 1860s, and in Spain it cost little more than sugar in the 1960s.

The annual sugar consumption in England in the 1700s (around 2 kg per person) could well have matched the honey consumption in the Middle Ages. In Europe honey was then 'the only sweetener' for most people, but sweetness was not a common characteristic of foods. This was still true in some parts of the world in the 1900s, and figures below for years around 1970 show how the approximate average consumption per person of honey and sugar then varied in three groups of countries (Crane, 1975d).

	Amount consumed/person/year (kg)		
	honey	*sugar*	*honey as % of sugar*
Asian countries			
India	0.003	6	0.05%
China	0.002	4	0.05%
Affluent honey-producing countries			
Australia	0.5	56	0.9%
New Zealand	0.5	53	0.9%
Israel	0.4	57	0.7%
Affluent honey-importing countries			
West Germany	1.0	40	2.5%
Netherlands	2.0	69	2.9%
UK	0.25	53	0.5%

Many affluent countries consumed much sugar even if they produced much honey. The two continental European countries cited ate the most honey, although they had to import much of it: they were affluent, and their ancestors had a tradition of eating honey for several thousand years.

The high consumption of sweet foods and drinks in many countries in the 1900s was a concomitant of the growth of the sugar industry, and had little to do with honey.

Much less is known about Africa. Dubois (1989) made a detailed study of the competition between honey and sugar in Ethiopia, Sudan and Egypt between 1830 and 1870. Egypt's sugar production rose to 3690 tonnes in 1850, but then decreased as more cotton was cultivated. The production and use of honey in Egypt during this period continued, but trade in honey contracted as and when sugar was taken to the African interior. In Asian countries honey was regarded as a medicine rather than a food.

46.6 Ensuring the purity of honey

Honey may suffer spoilage through contamination during harvesting, careless handling, or deliberate adulteration. From early times, regulations were made to prevent malpractices, and honey was graded by purity as well as colour by 1450 BC or earlier in Egypt (Section 20.33).

Around AD 800 in Europe, Charlemagne gave directions to stewards in charge of his royal estates to observe the greatest cleanliness with whatever was prepared by hand, and mead, honey and wax were mentioned by name (Guérard, 1853). In Muslim parts of Spain (711-1492) foods on sale in market places – including oil, butter and honey – were regulated, and steps were taken to prevent adulteration (Monferrer, 1991).

In 1406/07, honey merchants from Novgorod in Russia complained to Hanseatic merchants in Germany about short weights and increased prices, with the result that the Hansa merchants refused to trade in Novgorod (Galton, 1971). In 1457 in England, William Mason sued Richard Ruddying of Stonehale for damages for selling him a *cadum* of honey which was supposed to be pure but had been impregnated with sulphur and other impurities – probably when the bees were killed before harvesting the honey. Mason claimed damages of 40 shillings, from which Fraser (1958) suggested that the cask of honey was a full tun of 252 gallons.

In 1555 Olaus Magnus said that 'honey is conserved in these lands [northern Europe] in its purity without fraud or guile; though the product exported overseas is adulterated by the insatiable greed of merchants. But ... let no one henceforth set himself to learn how this hateful trick is performed.' There were attempts to regulate the purity and full weight of honey sold in various countries of Europe. In England a 1580 Act of Queen Elizabeth (Section 46.43) stated: 'The Makers and Sellers of Honey have not only used to put the said Honey in Cask of deceitful Assize, but have used also deceitful Mixtures of the same. ... All Barrels, Kilderkins, and Firkins filled with Honey by the Maker and Filler' were to have the man's initials burnt upon the head of the cask with a hot iron, with a penalty of 6s. 8d. for every cask not so marked. In 1586, Harrison said in *Holinshed's chronicles of England*: 'Our honie also is taken and reputed to be the best, because it is harder, better wrought, and clenlier vesselled up, than that which commeth from beyond the sea, where they stampe and streine their combs, bees, and young blowings altogether into the stuffe, as I have beene informed.'

Standards in England seem to have been lower in Hill's time (1759): 'In general the Honey which is commonly sold is so bad; partly from a dishonest mixture of flour and other ingredients, and partly from the ill manner wherein it is procured from the combs.' Hill had no sure way 'to discover the frauds that have been us'd in making up of Honey. But in general what is thin and transparent, from whatever place it comes, is the most likely to be pure; because all the common mixtures give it thickness and cloudiness.' But in 1780, Keys – like Harrison – regarded English honey on the market as cleaner than that produced elsewhere: 'As they have such prodigious quantities, it is very probable that the Apiators of those countries [that export honey] are not more cleanly or more careful in the extraction of it from the combs than the farmers dames of our own island.'

In 1866 Moses Quinby in the USA described a common method of adulterating comb honey, by 'placing a piece in a jelly cup and filling it up with glucose. If this were pure honey it would become candied and conceal the comb, yet these are found unchanged upon our grocers' shelves the year round.' In 1881 trouble arose with comb honey as a result of an improper (light-hearted?) statement by a USDA chemist in a popular journal: 'In commercial honey, which is entirely free from bee mediation, the comb is made of paraffin [wax], and filled with glucose by appropriate machinery.' Pellett (1938) gave details of the many repercussions of this, which led in 1897 to the formation of a United States Beekeepers' Union to combat the adulteration of honey, and government action was finally taken in 1906 (below).

When centrifugal honey extractors came into use for combs in movable frames, both retail and large-scale buyers of liquid honey suspected that the honey they bought might be adulterated. By then, the adulterant was usually a sugar,* and new chemical processes were being developed to produce different sugars; from about 1870 glucose rather than sucrose was the main honey adulterant in the USA. In 1878 Charles Dadant found glass jars in which glucose syrup had been substituted for honey, maple syrup and other expensive products. Such occurrences led beekeepers in the USA to initiate a petition to the Senate and Congress in the same year, for laws to be enacted for the suppression of 'this illegal business'. The petition (reproduced by Crane, 1975c) was supported by more than 30,000 signatures (Pellett, 1938). It was referred to the Commission on Ways and Means, but was never reported for action. However, the USA Food and Drug Act was passed in 1906, and although this did not mention honey specifically, it made illegal the presence in foods of additives, contaminants or substances injurious to health.

New Zealand had much trouble with imported adulterated honey at this period. Hopkins (1916) wrote: 'early in the eighties [1880s] some of the canning houses in America [USA] were flooding the markets of the world with spurious honey. ... In 1886 it began to be sold in New Zealand.' R.J. Kendall was told that it contained only 15% honey, which he confirmed; the rest was 56.5% glucose, 25% water, and flavourings. Similarly in England, in 1882 'there was a great deal of spurious and adulterated honey introduced into the country' (Cowan, 1928), and Dr Otto Hehner was appointed as analyst. Analysis of samples from Mr Hoge, 'an American speculator in honey' who advertised 'pure cut comb honey in glass jars', showed that the jars had been filled up with glucose and corn syrup.

From about 1900 invert sugar (glucose + fructose) prepared by the action of acid on cane sugar (sucrose) became available. Honey adulterated with it had an abnormally high content of HMF (hydroxymethylfurfuraldehyde), and Fiehe (1908) devised a test which detected this. Overheating honey also increased its HMF content, and either adulteration with invert sugar or overheating also led to a low content of the enzymes diastase (amylase) and invertase (Gothe, 1914; Duisberg & Gebelein, 1958), so these were also useful as indicators.

In the early 1970s a new adulterant became available which was then impossible to detect. A commercial enzymatic process had been developed which converted maize starch, a cheap carbohydrate, into glucose and fructose in a very similar proportion to that in honey. In 1978 White and Donner in the USA finally devised a method for identifying this so-called 'high fructose corn syrup' (HFCS) by measuring amounts of the isotopes ^{13}C and ^{12}C. The ratio of the two isotopes was different in honey and in HFCS, and White (1980) described methods for detecting this type of adulteration.

Fasler (1975) gave a detailed account of legislation in different countries on honey offered for sale, based on an accepted definition of honey and a specification for its composition. Germany probably had the most extensive and detailed regulations, the majority of them in *Verordnung über Honig* (1927-1930) and *Verordnung über Kunsthonig* (1930). By 1990, there were specific laws or regulations in 43 countries, and a code of conduct in a further 10; 15 others had at least one standard for honey. But apart from these 68 countries, some had no safeguards; for instance in

*But adulterants in Moscow in the early 1900s included potato juice, flour, chalk, sawdust and sand; 10 out of 13 samples of honey from a market, and all 4 of those from first-class shops, were found to be adulterated (Galton, 1971).

Figure 46.7a Primitive open-air beeswax extraction, Tharaka, Kenya, 1967 (photo: E. Crane).

Nepal, where honey cost four times as much as sugar in 1992, some jars on sale labelled honey might contain little or no actual honey.

46.7 Treating beeswax from natural nests and from hives

Beeswax, the other main product harvested from bees, was used for many purposes in everyday life in different parts of the world, and was essential for a number of technologies (Chapter 49). There was no revolutionary advance in methods of treating beeswax comparable with the introduction of a centrifuge to extract honey from combs in frames. Beeswax blocks were prepared from combs after the honey had been extracted, and the process has not changed in principle over the years. The combs were heated above the melting point of beeswax to liquefy the wax. On cooling, other materials present such as pollen, larval cocoons or parts of adult bees sank to the bottom and could be scraped off the solidified cake of wax. However, it was usual to remove most of the impurities by straining the wax while it was still liquid. In Figure 46.7a beeswax is being prepared with basic equipment: comb pieces are heated over a fire in the foreground; behind, melted wax from a previous batch is squeezed out of a strainer by means of two sticks, into a receptacle in a pit dug in the ground. Figure 46.7b shows a common type of strainer in Africa, used for beeswax or honey.

Figure 46.7b Woven bag for straining beeswax or honey, Kenya (IBRA Collection B70/62).

However, beeswax is flammable, and a better method – described by Columella – was to heat the wax in water, which also removed some impurities from the wax.

> The remains of the honey combs, when they have been well squeezed, after being carefully washed in fresh water, are thrown into a brazen vessel; water is then added to them and they are melted over a fire. When this has been done, the wax is poured out and strained through straw or rushes. It is then boiled over again a second time in the same manner and poured in such moulds as one has thought suitable, water having been first added. When the

wax has hardened, it is easy to take it out, since the liquid which remains in the bottom does not allow it to stick to the moulds. (XI.16.1)

Later, when a press was also used, pieces of comb were put in it inside a hessian sack or cloth which would serve as a strainer. Wax could be squeezed only if it was warm, so the wax or the press was preheated, or the wax was heated within the press by hot water or steam. Many examples of heavy wooden wax presses have survived from the last century. Figure 46.7c shows a Dutch example, and Segschneider (1978) illustrated a number from Museumdorf Cloppenburg in Germany.

When beeswax comb foundation was used in movable-frame hives (from 1857), combs were put back in a hive after honey was extracted from them. It became profitable to keep the beeswax yield as low as possible – 2% or even 1% of the honey yield – and to concentrate the bees' energies on honey production. (With traditional hives, complete honey combs were removed whenever honey was harvested, and the beeswax yield was around 8-10% of the honey yield.)

Figure 46.7c Wooden beeswax press, one of 13 in the Bee Museum, Odijk, Netherlands (photo: E. Crane).

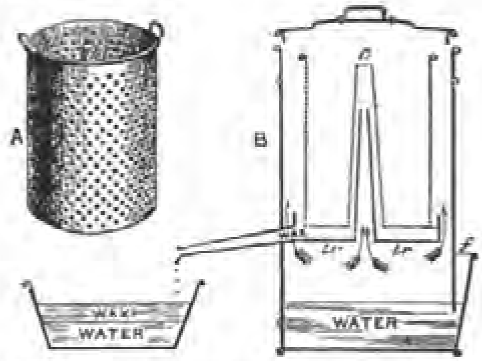


Figure 46.7d Gerster wax extractor (Cheshire, 1888). A = perforated comb-basket; B = section through extractor; c = central cone; *tr* = tray; *f* = filler for adding water.

Small-scale wax extraction continued to follow methods fairly similar to Columella's, but the wax might be heated by steam instead of water. Metal wax presses which superseded the wooden ones were described by Cheshire (1888), Cowan (1908) and Root and Root (1940). In other types the wax container was fitted with an outlet tube for the molten wax which rose to the surface. One early type is shown in Figure 46.7d, and the later Mountain Grey extractor was described by F.G. Smith (1960).

Solar wax extractors for rendering small amounts of beeswax were produced by Doolittle, Boardman and others in California from 1862. Pieces of wax were placed on the tilted and thermally insulated metal base of a shallow box, to be melted by radiant heat from the sun. The lid of the box consisted of two sheets of glass 5 mm apart, and the whole was placed so that it faced the sun. Melted beeswax ran down the base (leaving most of the dross behind), through a screen and into a mould where it solidified, further dross sinking to the bottom.

Beeswax was bleached for some purposes. Cowan (1908) described the process, and the relative ease of bleaching waxes from different parts of the world. Some of the most difficult waxes came from Cuba, Gabon and Gambia, and from Brazil – which probably contained some wax from stingless bees.

46.8 Trade and other transfers of beeswax

In contrast to honey, beeswax kept indefinitely, was easily transported and traded, and had a wide variety of technical uses. The wax merchant (*keropoles*) was mentioned by Aristophanes in Greece around 400 BC.

46.81 Tribute and other dues, gifts and bequests

Large amounts of beeswax changed hands in Ancient times. Various rulers of Corsica demanded much honey and beeswax as tribute, for instance 50 tonnes of wax after the peace with Rome in 181 BC, and 100 tonnes two years later (Section 22.14). Romans also took tributes of wax from Pontus and Africa, and the commander of the legion in a Roman province had to collect wax from the Procurator, to pass on to the Emperor. For instance a tribute of 150 pounds was sent to Claudius, Emperor from AD 41 to 54, via Zosimos when he was Procurator of Syria.

From the mid-800s, Norsemen from Scandinavia traded with Slav peoples and others farther south (who referred to them as Varingians), and took wax tribute from them, probably in the form of large balls known as *krugi* (Figure 46.8a). Around 1300 in the time of Marco Polo, the Tatar rulers took wax tribute from the Russians.

Beeswax was used as currency in various parts of Europe, especially to pay fines for certain offences. There are records from 1297 and 1384 in England, 1593 in Scotland and the 1480s and 1500s in Germany. In England, Scotland and Russia, many mediaeval rents were also paid in beeswax; Fraser (1958), Galton (1971b) and Walker (1988a) gave details.

Monasteries used much beeswax for making candles, and received it as gifts, bequests and dues. The following few examples are from many found in unpublished local English archives. In 1260 a wax candle had to be given free to the abbot or prior of Otterton in Devon whenever he visited Sidmouth, 'for him to read by'. In 1278 Roger Jeycors was master of a ship which ran into a great storm on a voyage to the Faeroe Islands, and he vowed that if the ship were saved he would offer a thanksgiving to St Edmund. On his safe return he collected 20 pounds of beeswax from his own bees and fashioned it into an anchor, which he and his apprentice took on horseback to Bury St Edmunds to make his offering to the saint. In 1506 Margaret, widow of John Norton, left all her bees towards keeping up a light in Bilborough church in Yorkshire, 'as long as it shall please God to preserve them'. Hives of bees that would produce wax for church candles were often bequeathed instead of beeswax itself.

Figure 46.8a Manuscript from about 1400 showing *krugi* of wax being paid as tribute in Russia (Khoroshkevich, 1960).

We know less about beeswax tribute in the Americas, but the Inca took it from a group of people in the Amazon basin, and about 1570 Spaniards took it from the Maya in Yucatan, Mexico. In Africa, tribute was much more commonly taken in honey, but there are occasional records of beeswax tribute in East Africa around 1900 (Seyffert, 1930).

46.82 Trade in beeswax

Beeswax was traded over long distances in early times. By the 400s/300s BC it was exported from Scythia, and also from many Black Sea ports (Bull, 1969, 1(4): 152).

Greek and Roman authors mentioned beeswax from Attica in Greece, Crete, Cyprus, Carthage, and Tarentum in southern Italy (probably imported). Beeswax was sent from Styria and Carinthia in Austria to Italy in exchange for other goods. Strabo commented that Turdetania in southern Spain exported large quantities of wax, and that Colchis in the Caucasus produced much (III.2.6; XI.2.17).

Christianity did not reach Russia until the 900s, and previously much of the beeswax produced there was exported, down the Dnieper from Kiev to the Black Sea, and thence to Byzantium, Venice and Genoa, where churches and monasteries already needed wax for candles. Greek ships took it across the Black Sea from Russia to Constantinople, paying a toll of 10% of its value at Hieron on the Bosporus. Ports to the north, south and east of the Black Sea were active up to the 900s (Ritchie, 1994), and beeswax was also traded from Mediterranean ports that included Cartagena in Spain, Syracuse in Sicily, Carthage in North Africa, Aquileia at the head of the Gulf of Venice, Corinth in Greece, and also Crete, Cyprus and Asia Minor.

In the 1300s German traders took beeswax in winter by sledge overland from Novgorod and Pskov to

Figure 46.8b Woodcut of German merchant whose wares included honey and wax, by Jost Amman (Sachsen, 1568).

the Baltic, then across the frozen sea to Gothland and Lübeck, overland again to Hamburg or Bremen, and thence round the coast to Bruges in Flanders (Galton, 1971a).

Many individual beeswax imports into England during the Middle Ages were between 10 and 20 tonnes. They came from Spain and Portugal via Bayonne into Bristol, Southampton and especially Sandwich; from Flanders and also Spain into London; from Flanders and the Baltic into Hull, Boston, King's Lynn and Yarmouth. In 1553 the Russians founded Archangel as a port for English trade, and most of their exports then went direct to London. During the Middle Ages beeswax imported to England from Livonia and other countries east of the Elbe was sold at fairs under the name Boleyn or Poleyn wax (Fraser, 1958). Figures 46.8b and 46.8c show merchants who sold wax, one in the 1500s and the other in the 1700s.

Many reports cited in Seyffert's (1930) historical study of literature on bees and beekeeping in tropical Africa indicate that much beeswax was produced, but that the people knew of no use for it until European traders bought it. Fontaine (1792) said that in Central Africa 'they throw away their wax; ... [in Nigeria] it is sold cheaply as a commodity of little worth'. Beeswax was traded from Madagascar by the 1200s (Bull, 1960, 1(4): 172). European merchants traded from Agadir and other Atlantic ports of Morocco, and beeswax was an important export from about 1500 (Meyers, 1977); a French consul said in 1698 that 'wax ... is the most significant trade item and the one about which the entire Barbary trade revolves ...'. In 1802 Durand reported of Senegal that 'the articles of export are slaves, wax, gold', and in 1845 Tams wrote of Angola: 'Next to ivory, wax is the chief product of the country, ... every caravan carried it as its chief ware' (Seyffert, 1930). According to Livingstone (1863), 'the principal occupation of natives outside their kraals in southern Africa was travelling to distant lands for their headmen, in search of wax and other products', and 'wax is offered

Figure 46.8c Copper engraving of a street wax seller, probably English, 1700s (source unknown). The caption refers to Spanish beeswax and offerings.

us for sale at every village'. Elsewhere he wrote of blocks weighing 80-100 pounds, and he thought that the wax trade was increased by the large export to Brazilian churches.

There was also trade in Asia. In 1835 Dr Wilson's *Narrative round the world* reported that in Timor, Indonesia, 'a considerable trade is carried on, chiefly in sandalwood and beeswax, which meets a ready sale in the Chinese market'. In North America, imports through Quebec in the 1700s are mentioned near the start of Section 31.23.

The net wax production probably decreased wherever movable frames fitted with comb foundation came into use from the late 1800s (Section 46.7). Tropical Africa continued to have large numbers of traditional hives, and it became the source of most of the world's beeswax. Some countries elsewhere with traditional hives also contributed; for instance most annual exports from Chile between 1914 and 1938 included from 200 to 350 tonnes of beeswax as well as 1000 to 2000 tonnes of honey (R.B., 1939). During the decade from 1963 to 1973, nine important beeswax-importing countries (seven in Europe plus Japan and USA) imported 47,957 tonnes, 37% of it from Africa: most from Angola, Tanzania and Ethiopia, and smaller amounts from twelve other countries. Morse and Nowogrodzki (1983) published statistics for USA production, trade and prices since 1940.

Estimates of total amounts traded internationally are necessarily vague, because few countries publish beeswax export or import figures. From what data I could collect (Crane, 1979), I estimated that perhaps 7000 to 10,000 tonnes were then exported annually, at least 5000 to 8000 tonnes of it from the tropics and subtropics, Latin America being the most important supplier after Africa. Mammo (1978) discussed factors that limited the world's beeswax supply.

46.9 Ensuring the purity of beeswax

Much less was written in the Ancient World about the quality and defects of beeswax than of honey. Plato (*c.* 427 to *c.* 347 BC) in *Theaitetos* referred to beeswax which was pure, dry, damp or dirty. Pliny probably judged beeswax by colour: 'the best is called Punic wax; the next best is very yellow' (XXI.49); Section 49.51 describes how Punic wax was prepared.

In the 800s Charlemagne gave orders to safeguard the cleanliness of beeswax (Section 46.6). Adulteration during the Middle Ages was referred to by Galton (1971), for instance in Gothland in 1332 and Novgorod in 1342. By the 1300s beeswax handlers in London had started to take corporate action to prevent adulteration, and in 1484 the Worshipful Company of Wax Chandlers was granted a charter by King Richard III; the Tallow Chandlers had already been formed into a Company in 1462. In 1581 'An Acte for the true melting making and working of Waxe' was passed in England (23 Eliz. c.8): it stated what was disallowed, what practices were mandatory, and what penalties were payable by offenders, including the following.

> Whereas by the Goodness of God this land yields great plenty of honey and wax not only for home consumption but also for export, but much wax has lately been found corrupt by reason of deceitful mixture. ... It is therefore enacted by the authority of Parliament that after the Feast of Pentecost next anyone concerned with trade who shall mix wax with resin, tallow, turpentine or other substance for sale, or shall offer it for sale, shall forfeit the said corrupted wax. If any shall have been actually sold, the person responsible shall forfeit 2s. for each pound sold ... To enable offenders to be traced, every melter and maker-up of unwrought wax shall have his own stamp or mark the breadth of six pence, graven with his initials and shall stamp every piece of wax triangle in three places, on the outside of the upper part, on pain of forfeiture of each piece unmarked.

The Wax Chandlers' Company was continuously active in trying to prevent malpractices. In an Ordinance of 1664: 'Wares and commodities of the Art, viz. torches, tapers, prickets, flamboys, etc., shall be of good and perfect wax and good wick, not mixed or corrupted with turpentine, resin, tallow, etc., except the casting of torch staves which cannot be done without' (Dummelow, 1975).

Seyffert (1930) quoted several reports of adulteration of African beeswax around 1900. Arabs in East Africa were said to use mutton or goat fat, and wax of other insects. In Morocco, 20% of tallow might be added, or even bean flour, oil, or large stones or other heavy objects. There, and in Angola and Sudan, red-hot rods were thrust into the wax to test it, and in some places the wax was sold only in thin cakes to prevent this malpractice. Adulterants listed by Cowan in 1908 included other waxes, resins and stearic acid, and he described tests to identify them. Walker (1983a) cited tests for adulterants published in ten countries since 1951.

After 1950 standard specifications were established in a number of countries, and Coggshall and Morse (1984) reprinted that of the American Wax Importers and Refiners Association in 1968. By 1990, 14 countries had laid down standards for beeswax offered for sale, and in 7 others there was a specification for beeswax in a pharmacopoeia (Crane, 1990a).

47

History of the Uses of Honey

Honey has been mentioned many times in earlier Chapters, especially where a record of its existence was the only indication that people collected it from nests or hives, and Section 46.4 discussed honey as an article of domestic and foreign trade. The present Chapter deals with honey as a substance in its own right, especially as food, sweetener, medicine and preservative.

In temperate regions of the Old World, honey was used primarily as a food and sweetener. In the tropics where other sweet foods were available, honey was used mainly as a medicine in Asia, and fermented to produce an alcoholic drink in Africa. In the American tropics honey from stingless bees was used as food and medicine, and to make an alcoholic drink. Honey was important in many religions, and some of its earliest recorded uses were as an offering to a god or spirit.

The following books contain sections on the history of honey:

1937 H. Ransome *The sacred bee*
1938 B.F. Beck *Honey and health*
1975 E. Crane *Honey: a comprehensive survey*
1980 E. Crane *A book of honey*
1984 F. Lerner *Blüten, Nektar, Bienenfleiss*
1987 J. Rudnay and L. Beliczay *A book of honey*.

47.1 Properties of honey on which its uses were based

Many uses of honey depend on its high sugar content, which is the source of its sweetness and of its high energy value, about 3 kcal/g. Honey consists mainly of the simple sugars fructose and glucose; these are absorbed directly from the alimentary tract into the blood, and thus provide a rapid energy source. Most honeys contain about 30-35% of glucose, which is less soluble in water than fructose, and honeys containing more glucose than average tend to granulate (crystallize) rapidly, some even in a few days. Honey has a higher fructose content than other natural foods (usually 35-40%). Fructose is very soluble in water, so high-fructose honeys tend to remain liquid. It is an exceptionally sweet sugar, and is very hygroscopic (absorbs water). Most of the properties of honey in baking are due to its fructose content (Hyvönen and Espo, 1981); cakes brown at a relatively low temperature and keep moist longer, and breads have an improved crust texture.

The proportions of different sugars in a sample of honey depend on the plant sources of the nectar, and so do the flavour and aroma of the honey, which produce organoleptic reactions. Certain volatile compounds from aromatic plants are especially important, and honeys from some localities became famous because such plants grew there (Section 47.21).

Honey has several antimicrobial systems (Burgett, 1990). Its acidity prevents the growth of many micro-organisms, and its high sugar concentration can kill them as a result of osmosis which dehydrates them. Also, the hypopharyngeal glands of worker bees secrete the enzyme glucose oxidase into nectar when the bees are processing it into honey, and some of the enzyme remains in the finished honey. The enzyme is virtually inactive in honey itself, but in honey diluted with water it breaks down glucose to produce hydrogen peroxide and gluconic acid. Hydrogen peroxide is microbicidal; it is unstable but is continually produced by the reaction. Honeys from certain plant sources have additional antimicrobial properties; Molan (1992) discussed these, and other relevant factors, e.g. treatment and storage of the honey before use.

Fermentation can occur in diluted honey if certain yeasts are present. Section 46.23 mentions the prevention of unwanted fermentation in honey during storage, and Chapter 48 gives the history of the controlled fermentation of honey to produce alcoholic drinks.

47.2 Honey eaten by itself, and with other foods

47.21 The Ancient World

Chapter 6 discussed honey in relation to early man. Evidence suggesting an early use of honey was found at a site in southern England: the presence of glucose on the surface of one excavated sherd dated to 3000-2650 BC, and of fructose on another (Section 9.43). Also, in Indo-European languages a word for honey was used earlier than a word for bee, suggesting that people spoke about honey as an entity before they spoke about bees or a bees' nest.

In early writings, honey was referred to around 2000 BC in Ancient China, and much more frequently by about AD 500, as a food and a medicine. Honey was described according to the site of the bees' nest from which it was obtained (Kellogg, 1968). Ground honey came from nests in the dry soil of the north, wood honey from nests in wood in the less dry south, and bamboo honey from nests in bamboos in Szechwan Province. Stone honey came from rock crevices and caves.

According to Joshi and Godbole (1970), Susruta – a famous surgeon in India around 1400 BC in Ayurvedic times – recognized eight varieties of honey produced from various plants by honey bees, stingless bees and wasps. Honey was praised greatly in the *Veda*, sacred books collected together about 1000 BC by Aryan people who moved into the Indus and Ganges valleys (Section 54.33); honey made life sweet, and was widely beneficial; it should be eaten by students of religion and philosophy; indeed, it should be eaten by all human beings. 'Let one take honey along with our valued diets to beautify his appearance, develop his brain faculty and strengthen his body. With honey he would digest properly all the foods' (Mullick, 1944).

In the 1300s BC in Ancient Egypt, when Seti I sent an expedition of a thousand men to Silsileh quarry for blocks of sandstone for his temple, the rations of the King's Messenger and Standard Bearers were: 'good bread, ox flesh, wine, oil, fat, honey, figs, fish, and vegetables every day' (Breasted, 1962, §208). Ancient Egypt produced much honey and also imported it.

Honey was frequently mentioned as a favourite food, and as one that prolonged life. Pythagoras (c. 530 BC) was said to have attributed his long life to constant use of honey. Athenaeus wrote later: 'Bread and honey were the chief food of the Pythagoreans according to the statement of Aristoxenes (c. 350 BC), who says that those who eat this for breakfast are free from disease all their lives' (*Deipnosophistae* II.47d). It was said of Plato, born about 427 BC, that as a baby 'the bees on Hymettus filled his mouth with honey'. Athenaeus related that in about 400 BC, when the philosopher Democritus wanted to die because he was so old, he ate less and less food each day. But when the time of a festival came round:

> the women of his household besought him not to die during the festival; so he was persuaded and ordered a vessel full of honey to be set near him, and in this way he lived many days with no other support than the honey; and then some days afterwards when the honey had been taken away, he died. Democritus had always been fond of honey ... (II.46f).

Ovid in Rome (43 BC to AD 17) was one of many to whom prehistory was characterized by abundant honey:

> First came the golden age when, with no threat of vengeance, of his own free will, without laws, man respected faith and righteousness ... now flowed rivers of milk and rivers of wine, and golden honey dripped from the green holm-oak ... (*Metamorphoses*).

Honeys preferred in Ancient Greece and Rome

In Ancient Greece, honey was appreciated according to its sweetness and quality, especially flavour and aroma. About 800 BC Homer's *Odyssey* referred to honey eaten at a meal: 'The sorceress Circe enticed Ulysses' companions, and fed them on cheese and bread and fresh honey with strong wine' (X.23d). Euripides (c. 484-406 BC) regarded honey from Salamis, offshore from Athens, as excellent. Strabo (20 BC to AD 21+) said that 'all the honey produced in the islands is, for the most part, good and rivals that of Attica, but the honey produced in the islands Leros and Calymnos [Kalimnos] is exceptionally good, and in particular the Calymnian'; the two islands are near the coast of Turkey. Pliny regarded honey from Sicily as of the best quality because it was 'stored in the calyces of the best flowers'; also 'honeycombs distinguished for their wax' are formed there (*Naturalis historia* X.12.32-33). Columella judged honeys by their plant source: 'thyme yields honey with the best flavour; the next best are Greek savory, wild thyme and marjoram. In the third class, but still of high quality, are rosemary and our Italian savory. ... Tamarisk and the jujube-tree ... have only a mediocre flavour' (IX.4.6). All honeys in his first three classes are from aromatic labiate plants.

The *Geoponica* (XV.7.1) included honey from Mount Hybla in Sicily among those that were good, and Virgil also knew about it:

> ... On your neighbour's border,
> The hedge whose willow blossoms are sipped
> by Hybla's bees
> Shall often with its gentle hum soothe you
> to slumber.
> (*Eclogues* I.53-54)

Other honeys renowned as especially fine, and widely traded, were from Hymettus in Greece, and Taranto and Brindisi in southern Italy.

Spanish honey was known but not liked in Ancient Greece from the time of Hesiod about 700 BC, and in Rome Pliny (XI.8.18) complained of the flavour of honey from thickets of Spanish broom (a legume, *Spartium junceum*).

Toxic honey

Honeys from a few plants, including several *Rhododendron* species, are toxic to humans. The effect was recorded in 399 BC when Xenophon's army retreated from Persia across Pontus in Asia Minor. Near the Black Sea coast at Trebizond, the soldiers ate honey – probably from *R. ponticum*, which grows there.

> [They] lost their senses and were seized with vomiting and purging, none of them able to stand on their legs. Those who ate little were like men very drunk, and those who ate much like madmen, and some like dying persons. In this condition they lay on the ground as if there had been a defeat. The next day none of them died, but recovered their senses, and the third day they got up as if they had taken medicine. (Xenophon, *Anabasis* 4.8)

It is not clear from the text whether the honey was collected from hives, but from the account in the next paragraph it may well have come from nests in trees.

Strabo (XII.3.18) described the military use of toxic honey from the same region in the Third Mithridatic War, probably in 65 BC, and it is likely that this honey also came from *R. ponticum*. The Heptacometae, inhabitants of Pontus, placed on the road by which Pompey's soldiers would pass through the mountains 'vessels filled with maddening honey, which is procured from the branches of trees. The men who had tasted the honey and lost their senses were attacked and easily despatched.' About 1200 men were probably killed on this occasion (Reid, 1995).

47.22 Other regions and later periods

We can be fairly certain that honey was eaten wherever there were social insects which produced it (Figures 3.2a, 3.4a), whether or not this was recorded in writing. From the 1600s onwards the introduction of honey bees to the Americas and Oceania greatly increased honey production in these regions. The world's total production and consumption of honey also increased as the human population became larger, and the increase was accelerated by the shift from traditional to movable-frame beekeeping. Table 41.8A indicates the world regions which became the greatest producers of honey. Sections 46.44 and 46.5 discuss those that consumed the greatest amounts of honey, and the chronology of the displacement of honey by sugar from sugar cane and sugar beet.

An early reference to honey in northern Europe was made by Pytheas in 344 BC; he noted that people near Ems (Germany) put honey on their bread. Two clay vessels found in a woman's grave dated to the AD 500s, near Thuringen in Germany, contained material that included pollen grains, and it was suggested that these had been in a honey or beeswax residue (Jacob, 1979).

Honey was eaten with some bland foods to make them more tasty, especially by people of high status. In Ancient Ireland the 'stirabout' fed to children in poor families consisted of oatmeal on buttermilk or water, eaten with stale butter. Sons of chieftains had barley meal on new milk with fresh butter, but sons of kings had wheaten bread upon new milk, taken with honey (Harris *et al.*, 1865-1901). An Anglo-Saxon manuscript refers to 'honey such as is used to lighten poridge', and the English nursery rhyme in which 'The Queen was in the parlour, eating bread and honey' dates from 1600 or earlier. In Switzerland, the physician Paracelsus, born in 1493, said: 'We do not bring up our children on wheat bread and mead [as in Vienna], but on honey, milk and cheese' (Bröker, 1964).

Although honey seems to have been a prerogative of the rich and powerful in some societies, the following examples show that this was not invariably so. A poem about an Irish hermit's enjoyment of life in the 600s included the lines (Bieler, 1966):

> I have a bothy in the wood -
> None knows it save the Lord, my God; ...
> But alone I live quite happy. ...

Eggs in clutches, and God gives mast, honey,
heath-pease;
... A cup of mead from noble hazel.

When the Moors were finally expelled from Spain in 1492, a few were kept to work the land, and a document sent to the King from Valencia in 1610 reported that 'they remain on their lands and farms by day and by night, surviving only on barley bread, honey, raisins and prickly pears, which they eat without interrupting their work' (Monferrer, 1991).

As a concentrated carbohydrate food, honey might be taken on long journeys into inhospitable country; according to a 1497 record a group of fur traders took $2\frac{1}{2}$ tonnes on an expedition to Siberia (Galton, 1971). Allsop and Miller (1996) discussed the status of honey in pre-industrial diets of certain peoples, from a nutritional viewpoint.

47.3 Honey in cooking

47.31 The Ancient World

Some cooked dishes in Ancient Egypt, Greece and Rome included honey, but few early recipes stated the quantity of each ingredient.

In Ancient Egypt, a scene in Rekhmire's tomb from about 1450 BC shows the preparation of triangular *shat*-cakes made with honey (Figure 20.3b is a beekeeping scene from the same tomb). Some cooks are sifting date flour, and others are frying the cakes; 'as a large jar of honey is a conspicuous object, it is safe to assume that honey was an ingredient' (Murray, 1963). Figure 47.3a shows a 'feast cake for a child' that survives from the same period; these were ornamented with the features of a face and body, and look like prototypes of the 'gingerbread man' still made in northern Europe. Written records mention the use of honey in cakes, for instance offerings during the reign of Ramesses III (1200-1085 BC) included '7050 *hin* of honey for cakes', '66 *hin* of honey for cakes' (Breasted, 1962, §300, §305).

In Greece Athenaeus quoted the description of a dessert in *Cretan women* by Euripides:

Cheese-cakes, steeped most thoroughly
In the rich honey of the golden bee.

A cookery book by Apicius in Rome from the first century AD was published in Latin and English by Flower and Rosenbaum (1958). Under the heading 'How to preserve cakes made with honey' he says: 'Take what the Greeks call safflower, make flour, and mix it with honey at the time you want to make the cakes.' Honey was used in all sweet dishes, or poured over them after cooking, for instance: 'Remove the crust from wheaten loaf, break up into largish morsels. Steep in milk, fry in oil, pour honey over, and serve.' Honey was an ingredient of many sauces and dressings: for birds – roasted crane or duck, boiled ostrich – and for fish. It was used rather less with meats, but in one recipe ham was boiled, the skin removed, criss-cross incisions made and filled with honey, and the whole encased in a paste of flour and oil before baking.

Figure 47.3a Honey feast cake for a child, length 10-12 cm, Deir el-Medinah, West Bank, Luxor, Egypt, c. 1400 BC (no. 1447, Agricultural Museum, Dokki; drawing by Sara Mougyi).

Apicius used honey to preserve many foods. Fresh figs, apples, plums, pears and cherries were placed alone in honey, turnips with myrtleberries in honey and vinegar. To keep meat fresh 'as long as you like without pickling: Cover it with honey, but suspend the receptacle, and use when required. This is better in winter; in summer it will keep in this manner only a few days. You can use this method also with cooked meat.'

Ancient Persian and Arab cuisines, themselves influenced by earlier Egyptian customs, included many sweetmeats containing honey which were recorded in a cookery book written in Baghdad in 1226 (Arberry, 1939) before the city was sacked by the Mughal army. Sugar was the usual sweetener, but honey was also used – perhaps when its flavour

would be retained after cooking. One or other was an ingredient in all sweet dishes and a few others:

	Sugar	Honey
halva (see below)	15	6
other sweet dishes	33	9
dishes with meat or chicken	12	2
dishes with fish	–	–
sauces, etc.	–	1
Total number of dishes	60	18

Many of the 'other sweet dishes' were based on broken pieces of white bread soaked in milk or oil, flavoured, sweetened and then cooked; flour was used for others. The custom of mixing honey with almonds, walnuts and pistachio nuts to make *halva* and other sweetmeats was inherited by Arabs from Persians. The Baghdad book contains the earliest honey recipes I know. One reads:

> Take equal parts of sugar, almonds (or pistachios), honey, and sesame oil. Grind the sugar and almonds, and mix together. Add saffron to colour, mixed with rose-water. Put the sesame oil into a basin, and boil until fragrant: then drop in the honey, and stir until the scum appears. Add the sugar and almonds, stirring all the time over a slow fire until almost set: then remove.

A modern Greek recipe (Crane, 1980a) is rather similar to the Baghdad one quoted above. In Egypt, a special *halva* shop in Tanta stocked a large number of varieties when I was there in 1978.

After the Islamic conquests from 632 onwards, Arabs spread to the eastern and then the western Mediterranean regions, reaching Spain with the Moors after 711. During the Muslim period Spain had specialist sellers of sweetmeats including *turrón*; this is still made in Spain and – as *torrone* – in Italy. Sweetmeats containing honey also survive in other countries bordering the Mediterranean, for instance *nougat* in France. Another ancient confection still made in some of these countries, and in Turkey, is *baklava*. Melted butter is poured over successive layers of thin (filo) pastry covered with various nuts before baking, and honey is poured on afterwards (see Crane, 1980a).

These sweetmeats were transmitted through southern Europe by Venetian and other merchants, but hardly at all in Christendom north of the Alps. Perhaps the ingredients were too rare and expensive there, but a French treatise on etiquette in the 1300s condemned nuts candied with honey 'which cannot be eaten in a cleanly fashion' (Toussaint-Samat, 1992).

47.32 Mediaeval times and later: Asia

In most of Asia honey was less used as a food, and comparatively few dishes containing honey are known. Section 48.6 refers to a honey drink in the Mongolian court in 1253, and there is a Chinese recipe from the 1200s in which yams were cooked, sliced and soaked in honey. In the 1300s before the Mughal conquests the Arab traveller Ibn Battuta, when a guest of the Sultan of Delhi, was given cakes something like the earlier Baghdad ones: 'round dough cakes made with ghee ... stuffed with a mixture of flour, almonds, honey and sesame oil, and on the top of each dough cake was a brick-shaped cake made of flour, sugar and ghee'. Leeming (1991), who quoted this description, reproduced a painting of a Hindu kitchen in the 1800s in which sweet cakes containing honey were frying, and also referred to some recipes from mediaeval Europe in which sugar was used, rare and expensive though it was.

Robert Knox (1681), held captive in Sri Lanka for nearly twenty years, remarked that the people 'have a peculiar way by themselves of preserving Flesh. They cut a hollow Tree and put honey in it, and then fill it up with flesh, and stop it up with clay. Which lyes for a reserve to eat in times of want.' In 1803, the Vedda in Sri Lanka still preserved meat in honey (R. Percival, from Bodenheimer, 1951).

47.33 Mediaeval times and later: northern Europe

North of the Mediterranean region where honey sweetmeats were favoured, the baking of spiced cakes spread during the early Middle Ages. These cakes were made with flour, honey, spices and sometimes eggs, but without butter or oil – suggesting that they originated in an area lacking dairy products, probably the eastern Mediterranean; see for instance Figure 47.3a. Paillon (1960) said that they were introduced by returning Crusaders or earlier travellers, and quoted Roger Vaultier, archivist at the Bibliothèque Nationale:

> In France, *pain d'épices* was known from the time of the first Crusade [1090s]. Agnes Sorel and Margaret of Navarre valued it highly, but its use declined under Henri II, on account of a rumour that the Italians (who exported large quantities to France) mixed poison with it. It

> came back into favour under Louis XIV, and since then its popularity has remained high ... In the 1400s and 1500s *pains d'épices* were manufactured in many French towns ... in Amiens in 1583 they were sold at a dozen for 5 *sols* [sous].

In Paris about 1500, *pain d'épices* made in Senlis was sold in the streets, the vendor singing a ditty which praised it as 'good for the heart'. A 1607 recipe for *pain d'épices de Reims* exists, and in Belgium *couques de Dinant* were famous. Switzerland had the similar *Lebkuchen* and *Basler Leckerli* (Crane, 1980a).

Most mediaeval lists of foods or their ingredients in England mentioned neither honey nor sugar, but Chaucer's *The Canterbury tales*, written between 1369 and 1387, contained the lines:

> They fetched him first the sweetest wine,
> Then mead in mazers they combine
>   With lots of royal spice,
> And gingerbread, exceeding fine,
> And liquorice and eglantyne
>   And sugar, very nice.

The custom of making spiced gingerbread without fat survived for many centuries; an 1865 cookery book 'by A Lady' includes a recipe.

In Russia in the 1000s and 1100s, a sweet cake was made from corn and honey; later it contained also almonds and milk, but spices were not mentioned. A 1551 record stated that some Russian monasteries received honey from the Tsar for making sweet cakes (Galton, 1971).

Some gingerbreads were shaped in a mould,* and others were made and decorated according to regional traditions; Figure 47.3b shows an example. Hanssen and Hahn (1963) described the blocks and moulds, and much information about gingerbreads and spiced cakes was given by Kopřivová (1961) and Bayerová *et al.* (1968) for Czechoslovakia, where gingerbread houses were a speciality. Beliczay (1960) wrote about Hungary, and Paillon (1960) and Fronty and Fronty (1982) about France. Hörandner (1983) published a study of gingerbread hearts, which were still presented as a sign of friendship, love or esteem in recent times, especially in Slovenia (Figure 47.3b) and German-speaking countries. When I was given one in Austria in 1956 the donor kissed my hand gracefully and offered the package with the words: 'I give you my heart.'

*Sweet cakes in the 1226 Baghdad book (Section 47.31) containing flour, nuts and sugar (but no spices) were also pressed into a carved wooden mould.

Figure 47.3b Slovenian gingerbread heart, with decorative icing (Luptovská-Horečná, 1972).

These and some other traditional uses of honey in cooking continued through the centuries. In North America and elsewhere, the increased honey production with movable-frame hives led Beekeepers' Associations and journals to promote the use of honey by publishing recipes; *American Bee Journal* included them from 1876. In high honey-consuming countries, even more honey cookery books were published after 1950.

47.4 Honey in medicine

For 4000 years writers have described medicinal, pharmaceutical and health-giving properties attributed to honey. Traditional medicine used honey for treating many disorders, and even today practically all the 200,000 traditional healers in Nigeria include honey in some of their preparations (Komolafe, 1995). It would be valuable if someone with the necessary specialist knowledge could make a detailed study of the early records of specific uses of honey in medicine, and the extent to which these uses were adopted by successive civilizations. Only an introduction can be given here.

Certain papyri surviving from Ancient Egypt indicate many features of medical remedies known

from later centuries, including the use of honey. The papyri are dated approximately between 1900 and 1250 BC, and are known by the following names: 1900 BC, Kahun; 1600, Edwin Smith; 1550, Ebers; 1350, London Medical; 1250, Berlin Medical. The Ebers papyrus (translated by Ebbell, 1937) is the largest and best preserved, and much of it consists of prescriptions.

47.41 Honey applied externally, and for preserving a corpse

The first known prescription using honey was written in cuneiform on a Sumerian clay tablet between 2100 and 2000 BC (Figure 47.4a), and it was presumably for external use. It reads: 'Grind to a powder river dust ... and [word destroyed], then knead it in water and honey, and let [plain] oil and hot cedar oil be spread over it' (Kramer & Levey, 1954).

According to Leibovici (1968), Babylonian and Assyrian medicine used honey in prescriptions for treating disorders of the eyes and ears. In the Ayurvedic medicine of Ancient India, a honey-butter paste was favoured for use after surgery, for instance to dress pierced or stretched ear lobes that were painful. Clarified butter or ghee was the commonest source of fat, and kept longer than butter from fresh milk. Susruta (c. 1400 BC), the famous Ayurvedic surgeon, treated infected wounds with a paste of honey and butter enriched with barley and four herbs.

In Ancient Egypt, the Ebers papyrus (c. 1550 BC) included honey in 147 prescriptions for external applications. It was used for treating eyes, and in the much later archive of Zenon's correspondence (200s BC) a man named Dromon wrote to Zenon: 'Order one of your people to buy me a *koytle* of Attic honey, for I need it for my eyes.' Honey was applied to expel spotted baldness of the head (alopecia areata); a recitation was made over 'red ochre, ——, alabaster, ——, honey, mixed together and applied thereto'. It was also: a component of dressings for wounds, burns, abcesses and suppurating sores, skin conditions due to scurvy; used to soften stiffness and make joints movable; after surgery, including circumcision; in suppositories, and in dressings inserted into the vulva for various disorders of the uterus, and in contraceptives. The Kahun papyrus lists a contraceptive containing crocodile faeces, honey and saltpetre, and entry 93 in the Ebers papyrus reads: 'To make a woman cease to become pregnant for 1 year, 2 years or 3 years, —— of acacia, ——, dates, are ground fine with a *hin* of honey, seed-wool is moistened therewith and placed in her vulva.' In the 800s the Arabian physician Al-Razi was said to have described the use of elephant faeces mixed with honey. In 1993 I was told that cotton soaked in honey and lemon juice was still used as a contraceptive in Egypt.

Figure 47.4a Reproduction of a clay tablet from Nippur, the religious centre of the Sumerians in the Euphrates valley, containing a prescription which refers to honey, c. 2100-2000 BC (IBRA Collection B58/17). See text.

The early use of honey in wound treatment recently received attention from several medical scientists. 'The Ancient Egyptians, Assyrians, Chinese, Greeks and Romans employed honey for wounds and diseases of the gut' (Zimia & Lulat, 1989). Two wound treatments used in Ancient Egypt – but not Ancient Greece – contained honey and other ingredients:

- boil together strong white vinegar, honey, alum from Egypt, roasted natron (sodium carbonate), and a little bile;

– boil together honey and flower of copper (red copper oxide).

A study of the work of Herophilus, founder of the medical school in Alexandria around 300 BC, identified the three most common 'non-magical' Egyptian techniques of wound care: placing a slab of fresh meat on a wound; applying a salve made either of honey and animal fat or of honey and aromatic resins; applying adhesive linen tapes.

Manjo's 1975 treatise on wound treatment in the Ancient World gave much information. The use of honey in wound dressing was carried over into Ancient Greece and into Rome, but was more or less absent from Hippocratic medicine. However, Hippocrates listed certain physical virtues of honey: 'It causes heat, cleans sores and ulcers, softens hard ulcers of the lips, heals carbuncles and running sores.'

Rather little is known about the use of honey in Roman medicine. Celsus recommended honey and lint for cleansing old sores, and Pliny said that wool was applied to them with honey. Honey was valued for treating ears. According to Galen (AD 130-201), 'honey infused warm by itself wonderfully helps exulcerated ears, especially if they cast forth ill flavours, as also their singings and inflammations'. Marcellus Empiricus, a medical writer who lived in Bordeaux about AD 400, said: 'Honey, butter and oil of roses, of each a like quantity, warm, helps the pain of the ears, dullness of the sight and white spots in the eyes.'

Mediaeval European leech books referred quite frequently to external uses of honey. An Anglo-Saxon manuscript written between AD 1000 and 1100, now in the Wellcome Historical Medical Library in London, has one recipe that starts: 'To make yourself an ointment for tumours, one shall take pure honey such as it is used to lighten porridge ...'; it then lists herbs whose juices may be incorporated. The *Leechbook of Bald* mentioned honey as a component of 'the best eye salve', also for treating styes, dirty wounds and internal wounds, after amputations, and to help the removal of scabs. But John Hill's book on the virtues of honey (1759) dealt only with its internal uses.

In 1937 Dold, Du and Dziao in Germany found that honey, especially when diluted with water, was effective in killing certain bacteria, and attributed the effect to 'inhibine' in the honey, whose nature they were not able to establish. In 1962 White, Subers and Schepartz in the USA identified the active substance in 'inhibine' as hydrogen peroxide produced by the enzyme glucose oxidase (Section 47.1). Honey applied to an open wound is diluted with body fluids, and hydrogen peroxide is produced which may encourage healing by inhibiting infection.

Honey for preserving a corpse

Hydrogen peroxide (above) is also produced when recently dead animal tissue is immersed in honey, and could help to inhibit putrefaction. In Ancient times honey was used for preserving a human corpse. According to Georghiou (1955), bodies were 'smeared with wax and buried in honey' during the reign of Sargon (2371-2316 BC) who ruled the people of Akkad. The Babylonians used honey for this purpose before the 1100s BC, and in the 400s BC Democritus in Greece was reported to have been buried in honey (Herodotus, I.198). When Agesipolis King of Sparta died at Aphytis in Chalkidiki in *c.* 371 BC, 'he was placed in honey and carried home' (Xenophon, *Hellenica* V.3.19). But in 360 BC the body of Agesilaus was preserved in beeswax, 'since they had no honey' (Section 49.73). Aelian's *Varia historia* (XII.8), written about AD 200, included the following – probably fictional – anecdote about Cleomenes I, King of Sparta from *c.* 520 to *c.* 490 BC.

> Cleomenes the Spartan took to himself from his companions Archonides and made him a partner in his affairs. He swore that, if he achieved power, he would do everything together with the head of Archonides. When he won power, having killed his companion and separated off his head and put it in honey, whenever he was going to do something, he would lean over the receptacle and say what he was going to do, and stated that he was not breaking his agreement or oath, but was consulting with the head of Archonides. (translation, A.J. Graham)

Egyptians did not usually preserve corpses in honey, but this was apparently done upon occasion. Between AD 1201 and 1207 Abd-Allatif al-Baghdadi wrote a book on things he had seen and events he had witnessed in Egypt (Sacy, 1810), and Budge (1972) published the following report by 'an Egyptian worthy of belief'.

> Once when he and several others were occupied in exploring the graves and seeking for treasure near the Pyramids, they came across a sealed jar, and having opened it and found that it contained honey, they began to eat it. Some one in the party remarked that a hair in the honey turned round one of the fingers of the man who was dipping his bread in it, and as

they drew it out the body of a small child appeared with all its limbs complete and in a good state of preservation; it was well dressed, and had upon it numerous ornaments.

There are many records about the body of Alexander the Great, who died in Babylon in 323 BC. A number do not mention honey, and perhaps those which do so only indicate a general practice. Publius Papirius Statius (AD c. 40 to c. 96) said that the body was 'steeped in the nectar of Hybla [honey]' (*Silvae* II.2.118). Budge (1933) quoted from an Ethiopic translation of an Arabic manuscript by Jiris ibn al-'Amud Au'l-Yasir (AD 1205-1274) the statement that Philemon prepared Alexander's body for burial and 'anointed it with aloes and placed it in a golden coffin, and he poured over it the honey of bees'. According to an Ethiopic translation of another mediaeval manuscript, when Alexander was dying he commanded a leaden coffin to be made and filled with honey, myrrh and oil of roses, that his body 'may be kept from corruption'. A number of other authors mention spices or perfumes but not honey. It is not known where Alexander was finally buried, and it cannot be said for certain whether honey was used.

Knox reported in 1681 that in Kandy, Sri Lanka, 'the people are said to embalm their dead in honey'. Earls of Southampton who died at Titchfield in England from 1550 onwards were said to be buried in honey: some of it leaked out and was found by workmen in the early 1900s (Crane, 1983a).

47.42 Honey in internal medicine (taken by mouth)

An Assyrian prescription reads: 'Rub the invalid's mouth with honey and purified butter.'

In the Sanskrit *Veda* of Ancient India (Sections 47.21, 54.33), honey was regarded as a remedy for many disorders, being soothing, nutritious, laxative, regulatory, and so on (Mullick, 1944). Doctors now practising Aryuvedic medicine say that addition of honey to a prescription makes the other ingredients act more strongly. The surgeon Susruta, believed to have lived about 1400 BC, attributed different medicinal properties to honeys from different plants, as did Charak a century or two later (Joshi & Godbole, 1970). In China the medicinal value of honey was referred to around 220 BC, and honey was 'a medicine of superior quality' in the AD 100s (Appendix 1).

In Ancient Egypt honey was included in 102 of the several hundred internal remedies listed in the Ebers papyrus. It was used especially for treating respiratory disorders with symptoms such as catarrh, phlegm, cough and asthma (a wheezing cough), and constipation, diarrhoea and intestinal worms, also for disorders of the digestive tract including the cardia (the oesophageal orifice to the stomach). Many prescriptions had unpalatable ingredients – for instance colocynth, senna, mustard, ink powder or malachite – and honey served as a 'gustatory corrective' for these. In others, honey was included as a binder.

In Greece, Hippocrates (c. 430 BC) made little use of drugs in treating patients. He prescribed a simple diet, favouring honey given as oxymel (vinegar and honey) for pain, hydromel (water and honey) for 'thirst', and a mixture of honey, water and various medicinal substances for acute fevers (Zimla & Lulat, 1989). He considered that honey was a very good expectorant, and recommended it for difficulty in breathing because 'it causes spitting'. He believed that honey 'with other things' was nourishing and induced a good complexion, but eaten alone it provoked urine and purged too much, so it attenuated rather than refreshed. Dioscorides, a Greek physician in the first century AD, often mentioned honey as an excellent medicine.

In Rome, the poet Lucretius (c. 99-55 BC) referred to the use of honey to disguise other flavours:

> Physician-like, who when a bitter draught
> Of wormwood is disgusted by a child
> To cheat his taste, he brims the nauseous cup
> With the sweet lure of honey.

So did Virgil, in connection with the 'sop to Cerberus' (end of Section 54.32). Celsus said in *De medicina* (c. AD 50) that a physician must heal in a safe, quick and pleasing manner, which could best be accomplished with honey; raw honey was recommended as a laxative and boiled honey for diarrhoea. Galen (AD 130-201) prescribed honey boiled, but not for too long. Aelian (AD 220s) reported that honey from Pontus cured epilepsy; Section 47.21 refers to a toxic Pontus honey.

Islam held the medicinal value of honey in a high regard. Sura 16 of the *Koran* referred to bees, and in verse 69: 'There cometh forth from their bellies a drink diverse of hues, wherein is healing for mankind.' Two hundred years later the book of Iman Sahih Al-Bukhari (translated by M.M. Khan) quoted the Prophet Muhammad as saying: 'Healing is in three things, a gulp of honey, cupping, and cauterization. But I forbid my followers to use cauterization' (verse 574). Monferrer (1991) gave an account of writers on honey in Muslim Spain. Somewhat before 1100, a physician in Seville, Abū Marwān Abd Al-

Málik ibn Zuhr, wrote a manuscript on the superiority of honey over sugar; this is lost, but a surviving manuscript by Avenzoar seems to summarize it. Another physician, Ibn el-Beithar, born in Malaga at the end of the 1100s, wrote the following about honey in his book of simples (herbal remedies); it is translated from Arabic via Spanish, and may be a much condensed version of longer passages.

> Honey dispels humours (body fluids), relaxes the bowels, is helpful in treating dropsy, preserves flesh and prevents putrefaction, stimulates the appetite, is good against facial tic. Mixed with sesame oil and boiled wine it is used as an emetic when poison has been swallowed. It is the best treatment for gums, and for teeth which it also whitens; it gives good results with tonsilitis; it stimulates coitus; taken with water it cleanses intestinal ulcers and enhances the effect of medication. Honey that has not been heated is useful against stomach chills, swelling of the intestines, and also stomach disorders due to the pituitary gland.

Many internal uses of honey in Ancient Egyptian medicine recurred in Greek and Roman texts, then in Arabic texts from Spain, and thence in mediaeval and later texts in languages of northern Europe. *The grete herball*, published in London in 1526, explained that 'hony ... is put in medycyns to delay and hyde the bytternesse of medycyns and that the medycyns go to the botom of membres bycause of the sweetnesse thereof'. So, for instance: 'To clense the stomake ... and to unbynde the bely. Take nitre with hony and it clenseth.'

In Germany, Roach's *Parnassus medicinales* (1663) versified the properties of honey.

> Der Honig treibt den Harn
> Und ist zur Lunge gut,
> Von Husten, Faulung auch
> Es stark bewahren tut.
>
> Honey drives the urine
> Is good for the lungs
> And against cough and decay
> A strong protector.

The first book devoted to honey was probably that published in England in 1759 by John Hill, whose curious character was summed up by David Garrick:

> For physic and farces his equal there scarce is;
> His farces are physic, his physic a farce is.

Hill's Chapters 4 to 8 are on 'the Virtues of Honey' against a tough Phlegm; against a Hoarseness; against coughs; and in the cure of Consumption. Many cough syrups nowadays contain honey, but Hill's contentions are no longer held that 'honey without rashness will be considered a cure for consumption'. John Hill published some seventy volumes, on a great variety of subjects, and B. Hill (1950) wrote a short biography.

47.43 Sources of further information

Some general contemporary accounts are quoted in the text; books below marked * refer to further books on past uses of honey in medicine, and the rest deal more with modern findings and opinions.

1885 J. Dennler *Der Honig als Nahrung und Medizin*
1938 B.F. Beck *Honey and health**
1944, 1971 B.F. Beck and D. Smedley *Honey and your health*
1950 W. Spöttel *Honig und Trockenmilch**
1960 P. Lavie *Les substances antibacteriénnes présentes dans le miel* (reprinted in Chauvin, 1968)
1968 R. Chauvin *Traité de biologie de l'abeille**
1969 D.G. Steyn *Honey as a food and in the prevention and treatment of disease*
1970 E. Herold *Heilwerte aus dem Bienenvolk**
1972 Mladenov *Mierea si terapia cu miere* (Honey and honey therapy)
1975 H. Duisberg *Wirkung des Honigs auf den menschlichen Korper*, in Zander and Maurizio (1975)
1976 Apimondia *Apitherapy today*
1983 Y. Donadieu *Honey in natural therapeutics*

47.5 Cosmetic uses of honey

Honey was used for various types of body care. The Ebers papyrus (*c.* 1550 BC) gave several recipes for skin treatments from Ancient Egypt, for example (Breasted, 1962, §88):

- To improve the skin, honey, red natron (hydrated sodium carbonate), northern salt, are ground together, and the body is rubbed therewith.
- To beautify the body: powder of alabaster, powder of natron, northern salt, honey, are mixed together with this honey, and the body is anointed therewith.
- To expel wrinkles of the face: turpentine, honey, issued *bdt*, are made into a dough and pounded

with viscous fluid, and the face is washed therewith very often.

During later centuries some famous women were said to use honey in skin treatments. For instance Nero's wife Poppea, who employed a hundred slaves to attend her beauty, used honey and asses' milk as a face lotion, and patrician women of Rome followed her example for many centuries. In France, honey was used extensively in toilet preparations, for example by Agnes Sorel, mistress of Charles VII in the 1400s; Margaret, wife of Henri II of Navarre in the 1500s; Mme de Sévigné in the 1600s; Mme du Barry, mistress of Louis XV in the 1700s. A book by J. Marinello published in Venice in 1574, *Gli ornamenti delle donne* (A lady's adornments), gave many details of the uses of honey in cosmetics – for hair, skin, lips, hands and eyes (see Chiavegatti, 1965). In England Queen Anne, to whom Warder dedicated his 1712 book on bees, *The true Amazons*, was also said to use honey.

Sarah, the beautiful Duchess of Marlborough in England, who died in 1744 at the age of 84, had 'the finest hair imaginable, the colour of which she said she had preserved unchanged by the constant use of honey-water' (*Letters*, ed. Wharncliffe, 1893); honey-water was made by mixing 2 tablespoons of honey with a litre of warm water. Mrs Dukeley, the Queen's tire-woman some years later, was said to use a recipe to preserve the hair and make it grow thick: rosemary flowers in a mixture of white wine and honey, distilled together, oil of sweet almonds added, shaken, and a little of the liquid rubbed into the scalp.

48

History of Drinks Made by the Fermentation of Honey

48.1 Honey-based drinks in relation to others

Alcohol is produced when yeasts ferment the sugars glucose and fructose,* which are the main sugars in honey and in fruits. When man first made fermented drinks, the yeasts were those present in honey or on the surface of the fruits. In particular, suitable yeasts are present on grape skins, whereas only those tolerant of sugars can survive in honey. From the AD 1300s prepared yeast might be used as an adjuvant, to increase fermentation and thus produce a higher alcohol content.

Table 48.1A lists source materials used for alcoholic drinks made from honey and water; wherever possible in this Chapter, I have used a term from column 1, although the same drink may also have other names.

Table 48.1A

Some alcoholic drinks of historical importance

For comparison, drinks made without honey are included (in brackets)

Alcoholic drink	*Likely source materials*
Honey wines	
mead/hydromel	honey with water
sack mead	honey with less water
tej, pombe, balche, etc.	honey and water, with adjuvant
metheglin	honey and water, with spices, etc.
(wine)	fruit juice, especially grape, or date or other sweet fruits
mulsum	wine mixed with honey and water
pyment/clarree	wine mixed with honey (and spices)
(wine)	tree sap, especially palms
Ales/Beers	
(ale/beer)	malted grain (barley, millet, maize, etc.) with water, and possibly hops
honey ale/honey beer	as above, with honey. In Africa the term was also used for drinks made without grain
bracket/bragget/bragot	e.g. ale mixed with honey or mead

*These are monosaccharides and can produce alcohol by direct fermentation, whereas disaccharides such as sucrose (cane sugar) and maltose cannot be fermented directly into alcohol.

An alcoholic drink was probably made from honey many thousands of years before wine and ale were produced. Early man is likely to have discovered that a mixture of honey and water, left in a warm place, might ferment into a drink which imbued the drinker with apparently magical feelings and powers. Fermentation could occur, for example, if rain fell into a vessel containing honey combs or honey.

Fruits for making wine, and cereals for making ale or beer, were cultivated from the Neolithic period which started about 6000 BC. Vine cultivation started roughly as follows in different regions (Johnson, 1971).

6000 BC	Mesopotamia, Caucasus
3000 BC	Egypt, Phoenicia
2000 BC	Greece
1000 BC	Italy, Sicily, North Africa
by 500 BC	Spain, Portugal, south France, possibly Russia; spread by Romans into northern Europe, also south-east Europe.

In general, vine cultivation and wine production became most important in the Mediterranean region and warm temperate parts of Europe. And when and where vines were grown, wine had a higher social status and tended to displace honey-based alcoholic drinks. Elsewhere the drinks made by fermenting honey often remained important. In cool temperate parts of Europe and in certain tropical regions, malted grain was fermented to produce ale or beer (there is no consistent differentiation between the two terms). In tropical Africa much of the honey harvested was fermented for a short time to produce what was called 'honey beer' although it often contained no grain. McGovern and Fleming (1994) explored the early history of wines, and Lucas (1962) described Ancient methods of making both wines and beers.

48.2 Honey-based drinks in the Ancient World

In the Sanskrit *Veda* of Ancient India, the word *mádhu* was used for both honey and mead; Le Sage (1975) traced the development of separate words for them in different Indo-European languages. There are around 300 references to *mádhu* in the *Rig-Veda*, some probably referring to mead. Also in the *Ramayama*, a contemporary epic, the forest dwellers drank *mádhu* and became intoxicated (Bapat, 1965). But the texts give no clue as to how this very early alcoholic drink was made.

Several Greek legends refer to a time before wine was known. Around 400 BC Plato recounted how Porus became drunk with nectar in the Garden of Zeus 'for wine was not yet known' (*Symposium* 203). Zeus made Kronos intoxicated with honey, 'for wine was not' (Nonnus, *Dionysiaca* XIII.258, written c. AD 400). In the 300s BC, hydromel, mulsum and oxymel had been recommended for treating many disorders, for instance by the Ionian medical school at Cnidus (west of Marmaris in present Turkey); Phillips (1973) quoted a number of prescriptions.

Around AD 100 'even now those of the barbarians who do not drink wine have a honey-drink' (Plutarch, *Banquet* 106). Many texts from Ancient Greece had referred to *nectar* or *ambrosia* as a food of the gods, and Hindu (Sanskrit) texts from Ancient India had referred similarly to *soma*. Any of these may have contained honey, either fermented or as a sweetener; Ransome (1937) devoted a chapter to this confused subject.

Section 48.1 suggests that wine was known in Greece by about 2000 BC, and Table 48.2A indicates honey-based drinks mentioned by classical authors. In the first century AD, mead was made from honey and rain water in the proportion 1 to 3, kept in the sun for forty days 'at the rising of the Dog Star' (Pliny, *Naturalis historia* XIV.17). Columella gave a recipe for *mulsum*, and several for *hydromel* in one of which a *sextarius* of honey was used with 2 *sextarii* of water (XII.12.3). For *mulsum*, 10 pounds of honey were added to an *urna* of must from grapes, about 24 pints (XII.41.1).

Only a few classical authors wrote in praise of mead (Fraser, 1951a), but in Rome *mulsum* seems to have had a higher status by the first century BC. Appius said that he was not accustomed in his youth to drink *mulsum*, 'for the sake of thrift'. After receiving a legacy, and being no longer poor: 'I, for the very first time, began to drink *mulsum* at home myself, though meantime mulsum was none the less commonly served at banquets almost daily to all guests' (Varro, III.16.1,2).

Religious prohibitions

Certain religions forbad alcoholic drinks, including mead. Islam was one, and this is clear in the book of Imam Sahih Al-Bukhari, who died perhaps two hundred years after the Prophet Muhammad; an English translation was published by M.M. Khan.

> Allah's apostle was asked about Al-Bit, a liquor prepared from honey or grapes which the Yemente used to drink. It is possible to drink it as long as it is not fermented. Allah's apostle said: 'All drinks that intoxicate are unlawful to drink.' (Verse 492)

This prohibition had a widespread effect on the later use of honey in Africa (Section 48.4).

Alcoholic drinks were also forbidden to Buddhists and Jains in India (see end of Section 54.34).

48.3 Honey-based drinks in Europe

Oosten (1985) explored the position of these drinks in Indo-European mythology. We know most about them in countries whose early writings have been preserved. The first mention in Europe outside the Roman world was in the description by Strabo (60 BC to AD 21) of a voyage in the late 300s BC by Pytheas, a Greek mariner of Marseilles (*Geographia* IV.5.5), and it probably referred to a type of honey ale. Pytheas sailed north of Britain for 6 days, into the region of the midnight sun, and reached a land (not identified) inhabited by barbarians who lived by agriculture; they had millet and herbs, roots and

Table 48.2A
Main honey-based drinks mentioned by Greek and Roman authors
Based mainly on Fraser (1951a).

	Plato c. −400	*Varro c.* −50	*Columella c.* +60	*Pliny c.* +60	*Palladius* +300s	*Geoponica c.* +950
aqua mulsa, hydromel (mead)	x	x	x	x	x	x
mulsum wine (mixed with honey and water)	o	x	–	x	–	–
oxymel (vinegar)	o	–	–	x	–	x

In column 2, o refers to writings from Cnidus (−300s): see text.

fruit, and 'from grain and honey they made a fermented drink'.

48.31 Eastern Europe

About AD 300 Huns settled in the Danube lands, and there are records of mead offered instead of wine, also of '*medos*' served at the court of Atilla. In or before 900, Prince Piast near Kruszwieca in Poland kept bees and made his own mead, and always offered it to his guests (Bessler, 1886). Galton (1971) found a number of early records relating to Russia. A Persian manuscript *Hudud-al-Alam* from about the 900s said that the Slav land had 'very much honey from which they make wine and such drinks. They make vessels for the wine of wood ... .' In 946 Olga – the widow of Igor, Prince of Kiev, and regent for her son from 945 – commanded the Drevlyane to bring much mead for the funeral feast of her husband (whom they had killed), and when they got drunk on it she ordered her followers to kill 5000 of them. In 996, a seven-day feast was held at Vasil'ev to celebrate Vladimir's victory over Turkish Peshenegs, and 300 large vessels of mead were supplied for it, perhaps about 5000 litres. In the 1100s Russian monasteries bought much honey for making mead; it was their second most important purchase after wheat.

There is no record of the addition of an adjuvant to increase fermentation until the 1300s, when yeasts from rye or barley were added and, later, those from potato juice. Hops were used in making beer during the 1300s or early 1400s, and in 1436 Vasily II in Russia gave his treasury the exclusive right to use hops when brewing with honey to produce 'honey beer', called *pure*.

Figure 48.3a shows a merry scene of mead drinking in the 1500s, a period when foreign visitors to Russia praised the mead as the best in the world. In 1557 Anthony Jenkinson reported that various berries were used in the production of 'meades' at the Russian court, and in 1582 *boyarsky* was made for the Tsar from fine, light and clarified honey. By the late 1500s very large amounts of mead were produced and drunk, and Ivan IV and Boris Godunov tried unsuccessfully to restrict them. Up to the 1600s both rich and poor drank mead, and a decree in 1654 allowed ordinary people to make it for festivals on payment of a tax. Then beer, wine and vodka became more common, and by the 1800s only the poor drank mead; from 1840 they were not taxed for making it.

In Poland in 1962, beekeeping co-operatives still made mead on a large scale, using traditional methods but modern control techniques. At Krakow two types were produced: *Trojniak*, and *Dwojniak* which was kept in 3000-litre tanks for 5 to 7 years before bottling and whose alcohol content reached 16%.

Figure 48.3a A woodcut showing Caucasian peasants drinking mead, and its effects (Olaus Magnus, 1555).

48.32 Western continental Europe

A 500-litre bronze cauldron was found in a Bronze Age tomb near Stuttgart in Germany, dated to about 550 BC, and the residue of pollen (and beeswax) in it showed that it had contained mead or honey. There were also nine horns in the tomb, all covered with gold leaf (Hammond, 1987). In the north of Germany, a drinking horn dated to before AD 100 found in a peat bog in Skudstrup, Kreis Hadersleben, contained yeasts and pollen grains, suggesting that it had also held mead (Grüss, 1931).

Mead as well as beer was made on estates in the northern Frankish-German lands, and it must have been plentiful in Meissen in the Upper Elbe region in 1015, for it was then used to put out a fire, for lack of water. There were mead breweries in Ulm on the Danube in the 1100s, also in Danzig, and Riga in Livonia. In the 1500s Hapsburg rulers granted special privileges to mead brewers, who were also once very important in Munich in Bavaria – later famous for its beer (Bessler, 1886). Certain towns in Bohemia had many mead houses; for instance Eger had 13 in 1460, although only one in 1684 after the Thirty Years' war. Some of the breweries may have produced honey ale or beer rather than mead. In other areas, including Rhineland, wine displaced mead rather early in court circles, and from the 1100s only peasants and townsmen drank mead.

In Switzerland, professional mead makers existed by the 1300s, and their procedures were controlled by the authorities. Between 1300 and 1600 the town accounts of Bern had entries recording purchases of mead, which must have been a common and popular drink (Sooder, 1952). Mead continued in use longer

Figure 48.3b Wall painting in Ørslev church, Denmark, showing two princesses welcoming guests with mead or a similar drink, c. 1350 (Højrup, 1957)

in Switzerland, Prussia, and Bavarian and Austrian regions, but it finally gave way to wine and beer.

Clutius' book on bees published in Leyden (1597) included two recipes for mead, and others for making vinegar and brandy from mead. Schoonenberghe (1981) reprinted these, and one for mead from a 1730 Dutch book on wine. An anonymous German book *Der vollkommende Bierbrauer* with a supplement on mead making was published in Altona and Leipzig in 1795.

Marchenay (1979) searched out details of honey-based drinks in different parts of France during the Middle Ages. In the 1300s and 1400s, a slightly fermented drink flavoured with herbs (*borgerastre* or *borgerase*) was made in Lorraine. In the nearby Metz region, hydromel was prepared in the usual way, but in the high Vosges to the south-east the whole contents of a skep of bees was crushed, and the blackish mixture added to water to make *miessaule* or *miessaude*. A similar drink in Savoy was *bochet*, and in Brittany *dour mel*. Drinks made from honey became much less important than wines when and where grapes were grown. A 1471 Order of the Provost of Paris laid down qualities required for alcoholic drinks sold by Paris Taverners, but hydromel was not mentioned (Piqué, 1924). Other French writers including Vouloir (1935) also wrote about the production of honey-based drinks.

48.33 Scandinavia and Baltic lands

The earliest hint of a honey-based drink in Scandinavia comes from a find in the Bronze Age grave of a girl at Egtved in Jutland, probably dated about 1500 BC (Thomsen, 1929). Sediment in a small birch-bark bucket contained wheat grains and pollens from bee plants including lime, and this led Dickson (1978) to suggest that the bucket contained honey, or ale or beer based on honey.

Wulfstan is said to have told Alfred the Great, King of Wessex from 871 to 899, that Estonians had so much honey that the king and nobles drank mare's milk, and left mead to the poor and the servants, beer being unknown (Gayre, 1948).

The Anglo-Saxon poem *Beowulf* probably originated around AD 700 in Northumbria in England, but it was actually set in Denmark. The following lines (from Moncrieff 's 1921 translation) relate to mead.

> ... A Hall house he would have
> Made him by men a mightiest mead-place
> Than men's offspring remembered ever. (68-70)
>
> She to Beowulf, braceleted Queen,*
> Noble-minded the mead-bowl bore. (627-628)
>
> ... Then from the sills fell
> Mead-benches many ... (775-776)
>
> ... Nor in all my life saw I
> Under heaven's vault, among sitters in hall,
> More joy in their mead. (2015-2017)

Figure 48.3b, from about 1350, shows the offering of mead or a similar drink to distinguished guests in Denmark. In 1548 King Christian III demanded 66 tonnes of mead from his vassals, and in 1590 24 tonnes were used at a princess's wedding. In 1621 a Danish poet praised mead from the island of Fyn, which he said was appreciated even in Kuwno, capital of Lithuania (although this town exported honey).

The *Heimskringla*, sagas of the Norse kings, said that King Harold of Norway and his men had 'entirely new [drinking] vessels and horns adorned with

*Queen Wealtheow of Denmark, wife of Hrothgar.

gold, all with carved figures and shining like glass', also deer horn cups and mead-bowls.

Finnish people originated among Finno-Ugrian ancestors living in the middle Volga region about 2000 to 1000 BC, who practised tree beekeeping (Section 16.2). Although Finland itself is too far north for the survival of wild honey bee colonies (Section 9.5), there are many references to honey and honey 'beer' in the Finnish epic poem *Kalevala*. These may be a survival from the life of ancestors before their migration; however, when Elias Lönnrot published the *Kalevala* in 1835-1849, he added other material to the orally transmitted songs on which it was based, so the bee-related passages may be among his additions.

Iceland was probably settled between AD 870 and 930, by Vikings who came mainly from Norway and from Viking settlements in Britain and Ireland. The *Poetic Edda*, collected in the 1200s, often mention mead; for instance, brave Viking men who died in battle were believed to feast afterwards in Valhalla, drinking mead. The poems are thought to reach back to the roots of Germanic mythology and legend (Jones, 1968), and these may perhaps be the source of the references to mead.

48.34 Britain and Ireland

England and Scotland

In Scotland, a Bronze Age burial at Ashgrove in Fife contained deposits of pollen grains which had probably been in honey or a honey-based drink (Dickson, 1978).

In eastern England, two 2-litre horns were found in a grave at Sutton Hoo dated to about AD 625; they were from aurochs, which then still lived in central Europe. Drinking horns (which were illustrated by Fröier in Sweden in 1960) were used for mead or ale. But by the 1200s the traditional vessel for drinking mead in Britain and Ireland was a wooden bowl or tankard, which might be ornamented with silver and was sometimes known as a mazer or mether; Figures 48.3c and 48.3e show examples. In 1328 the refectory at Christchurch in Canterbury had 182 of them, and Birch (1959a) described some that had survived, the oldest from 1307. Crane (1983a) referred to others.

From the 1400s onwards, preference in England started to change from dry wines to sweet wines with more flavour, and the popularity and status of mead began to decline (Gayre, 1948). A sweeter sack mead (made with twice as much honey) became fashionable, also metheglin in which spices or other flavourings were added during the fermentation.

Figure 48.3c The Bannatyne or Bute mazer from southern Scotland, 1500s (Gayre, 1948). The bowl is of wood, with rim, base and side strips of silver.

Samuel Pepys the diarist drank his first 'brave cup of metheglin' in 1660, and in 1666 'had metheglin for the King's own drinking, which did please me mightily'. In 1669 Sir Kenelme Digbie published *The closet ... opened: whereby is discovered several ways for making of metheglin, sider, cherry-wine, etc.* It included about a hundred recipes for honey-based alcoholic drinks; whether called meath or metheglin, or by some other name, all contained additives to increase the flavour: spices, herbs, fruit, flowers, and sometimes hops; the hop plant had been used in brewing since the 1200s and its use was introduced into England about 1400.

Birch (1959b) found references to mead in English literature from the late 1300s to the 1800s. Chaucer used the word *meeth*: 'He sent hir piment, meeth and spyced ale', and 'Her mouth was swete as bragot or the meeth'. In the late 1500s Shakespeare mentioned 'metheglin, wort and malmsey' in *Love's labour's lost*. Carmichael's collection of surviving rites and customs in the highlands and islands of Scotland (1928) included the offering of 'mead, ale, or gruel' to the god of the sea on St Columba's day, 9 June.

Wales

A Welsh poem *Y Gododdin*, written in the 500s by Aneirin about his contemporaries, described an event in the war against the English. Before the Welsh attacked Catraeth (Catterick, in North Yorkshire), which the English had captured, three hundred warriors feasted on mead, with the result that they were killed during the battle. The poem contrasted the sweetness of the mead with the bitterness of the subsequent tragedy:

Men went to Catraeth, keen was their company,
They were fed on fresh mead, and it proved poison.

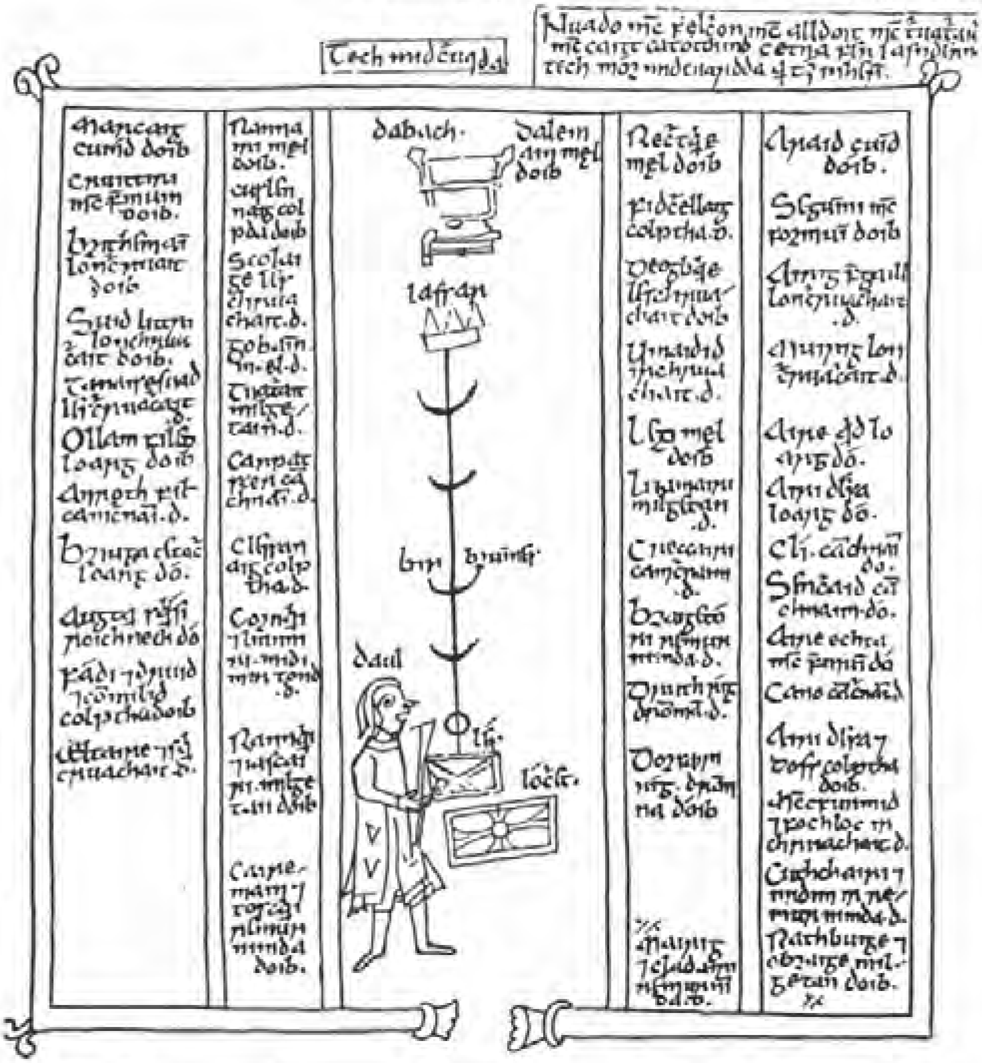


Figure 48.3d Reproduction of a seating plan for the great mead hall on the Hill of Tara (*Book of Leinster*, 1100s, reproduced by Trinity College Dublin, 1880). See text.

Figure 48.3e Irish methers (square drinking vessels) from the 1600s and earlier (National Irish Museum).

Men went to Catraeth with the dawn.
Their fine spirit shortened their lives,
Mead they drank, yellow, sweet and ensnaring.
(A. Conran, *Penguin book of Welsh verse*)

In *Y fêl ynys* (The isle of honey), a beekeeping book in Welsh, Williams (1972) quoted this and many other references to mead; early Welsh poetry and prose often mentioned mead and bragget (Gayre, 1948; Williams, 1972).

The high status and importance of mead among the Celtic inhabitants of Wales is clear from the Ancient Welsh Laws – first written down in the 1200s – which paid much more attention to mead than to honey. A great deal of the honey produced in Wales was destined for mead made for the court of the King or of a lord. Twice a year the freemen had to pay entertainment dues (*gwestfa*) to the King for his bread, his savoury and his drink. A free township with the King's local administrative officer had to supply 'the worth of a vat of mead to the King, which ought to be capacious enough for the King and his adult companion to bathe in it'. This would be perhaps 500 litres. 'From a free township where there is no office, ... if mead is not to be had, two vats of bragot are to be paid; if bragot is not to be paid, four vats of ale are to be paid.' Laws of Wales in the Book of Blegywryd explain in detail how much mead the King's officers were to be given. The King's mead brewer was paid not in mead or honey, but in beeswax: one-third of the wax left in the vat after the mead was made.* He also received woollen clothing from the King, and linen clothing from the Queen three times a year, and had other benefits. Crane and Walker (1984/85) gave details.

Ireland

Although the Ancient Laws of Ireland do not mention mead, other Irish manuscripts do so. A penitential from about the 800s referred to the sin of 'drunkenness from drinking beer or a measure of mead', and a manuscript from the 900s used the term *gair meda* for 'a shout of [those that drink] mead' (Kelly, 1990). Figure 48.3d, from the 1100s, shows a seating plan, reputed to date from the 200s, of the House of the Mead Circuit on the Hill of Tara in the Boyne valley north of Dublin. Food was distributed by the man shown in the centre, and lights to illuminate the hall are shown immediately to the right. Above is the cooking spit, and at the top the mead vat, *dabach*; a mead cup (not shown) was *mid-chuach*. Writing on the left and right of the plan indicates the places where persons belonging to certain grades of society should sit, and the joint of meat with which they should be served. Figure 48.3e shows Irish methers (mazers); Gayre (1948) said that these were used solely for mead.

*Combs containing honey were probably put in the vat.

48.4 Honey-based drinks in Africa

In tropical Africa, most of the honey produced was traditionally fermented to make what was called honey beer, although the best types were made with honey only and no grain. (Beer from millet or – after its introduction – maize was common in Bantu societies which occupied much of the region.) Beer or honey beer was essential for fulfilling many social obligations; it was carried to chiefs as tribute, and used to reward labour; an abundance of it was the glory of a chief 's court or of a commoner's hospitality. Without it, tribal councils could not be held, and marriage or initiation ceremonies did not take place (Richards, 1939). Figure 48.4a shows localities for which Seyffert (1930) found records of the making or consumption of alcoholic drinks from honey. He devoted nearly twenty pages of his book to these drinks, quoting many records from the 1800s and listing peoples who did or did not make them.

Muslims conquered the north coastal region in the 700s, and a wide belt south of the Sahara was converted to Islam later: from Somalia and part of Ethiopia in the east, through parts of Sudan, Chad, Niger and Nigeria to Mali, and Mauritania on the west coast. Islam also reached the east coast as far south as northern Mozambique and Madagascar. In such areas alcoholic drinks may have been used before conversion to Islam, and in unconverted south-east Madagascar the Vezo fermented honey in water for a week to make an alcoholic drink (Fert, 1985).

Some other areas without records of honey-based drinks in Figure 48.4a were occupied by nomadic peoples whose honey hunting did not develop into hive beekeeping: Pygmies in equatorial rain forests (Figure 8.1f) and San in southern Africa. The three records farther south in Figure 48.4a indicate Khoi (Hottentot) people.

Drinks from honey and water only

Strabo wrote of the nomadic Troglodytes of Ethiopia: 'Most of the people drink a brew of buckthorn, but the tyrants drink a mixture of honey and water, the honey being pressed out of some kind of flower' (XVI.4.17). There was no mention of fermentation. In

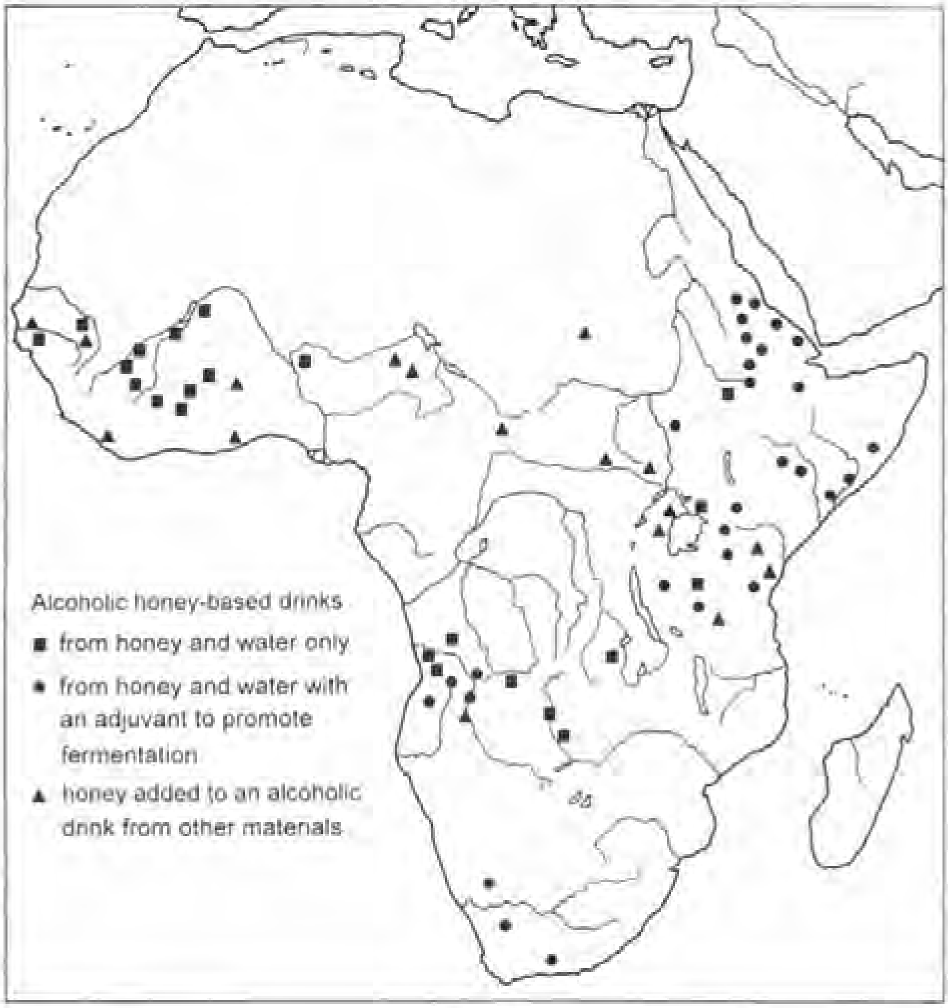


Figure 48.4a Map showing location of records of alcoholic honey-based drinks in Africa (Seyffert, 1930).

Figure 48.4a most of the locations indicating alcoholic drinks made from honey and water only were in West Africa and what is now Angola. Manod *et al.* (1951) quoted from a Portuguese report on the west coast of Africa, written between 1506 and 1510: 'People took honey with its wax and mixed one part of honey to three parts of water. The mixture was kept in closed pots or calabashes, and left in the sun or near a fire for 12-15 days, to keep warm. The pots were then opened, and the wax – which had come to the top – was removed.'

Drinks from honey and water with an adjuvant

In many areas, particularly in the east (Figure 48.4a), honey was fermented in water for a longer period, with the root or some other part of a specific plant which had been found to increase fermentation and thus give a higher alcohol content.

One of the most famous of these drinks was *tej* or *t'edj* in Ethiopia; Christianity had arrived there in the 300s, and alcohol was not prohibited. Beckingham and Huntingford (1954) quoted from a report made in the early 1600s: 'one part of honey and 5 or 6 parts of water are put into a pot with a handful of toasted barley which makes it ferment. Afterwards they add some morsels of *sado* wood [*Rhamnus tsaddo*]. It is ready to drink in 5 or 6 days, and is drunk after – not with – meals. In noblemen's houses and the Emperor's, many guests are always invited. There is no conversation without the wine circulating and being drunk in turns until they are laid out. ... The wine is really very mild and if it were drunk in moderation no harm could be done.' Before 1900, *tej* was made only in houses of the ruling classes, and originally it was drunk only by the King and others in his presence. The honey for making it was received as taxes and land rents (Fichtl, 1995a). Rossi (1959)

found that *tej* contained 8% to 13% alcohol after fermentation lasting for 2 to 3 weeks. Several sugar-tolerant yeasts were found in it: species of *Saccharomyces*, and also *Hansenula anomala* which is especially glucose-tolerant. In 1973 I visited the largest honey market in Addis Ababa, which bought honey from beekeepers and sold it for making *tej*; the high building was stacked with bags made by sewing two goat skins together, each containing about 50 kg of honey. Fichtl (1995a) gave more recent recipes and referred to the addition of dried leaves of *gesho* (*Rhamnus prunoides*).

In Kenya, the word *pombe* was used for any type of beer. It might be brewed in a calabash at home, or in an old cask or drum in a village beer hall. Water was added to the broken-up honey combs (some likely to contain pollen and brood) and often also slices of the loofah-like fruit of the sausage tree, *Kigellia africana* (Bignoniaceae), which grows widely in tropical Africa. The slices were dried between successive uses, and probably transferred yeasts from one brew to the next. Or *ladde* fruit, resembling apples, might be added as an adjuvant (Seyffert, 1930). *Pombe* was consumed within a day or two of the start of fermentation (Paterson, 1975).

Nightingale (1983) recorded customs in the early 1900s among the Kikuyu, which probably existed among many other peoples of East Africa. A man wanting to marry must first approach the girl's father, offering a bride-price gift of animals, and of honey for making 'beer' – or alternatively 'beer' already made; Kikuyu got their honey from the Wandorobo (singular, Dorobo) in neighbouring forests. The more the suitor could afford to offer, the better were his chances. The bride-price might be less than 5 litres of honey, or up to say 20 litres or more; it was given over a period of time and always used for 'beer'. This was made by men, and occasionally by women although only the very old men drank it. Beer was a universal drink for old men, who were no longer physically of much use in the community but were looked up to for their advice; men in the young warrior age group did not drink it. In southwestern (non-Muslim) Sudan studied by Brown (1984), peoples of the Wau region used 'indigenous yeasts' when fermenting honey to make beer known as *duma*. Belanda-Bor added yeasts from tamarind, beans or other plants; Ndogo added ground-up beans or sprouted sorghum. Some fermentation times were as short as a few hours. Women usually made *duma*, although men would do so when away at camp. Several beekeeping peoples preferred to sell their honey to women brewers in Wau town, who gave them the best price, and many single Belanda-Bor women

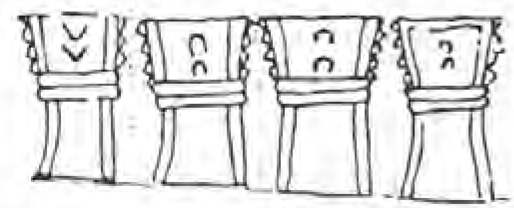


Figure 48.5a Drawing from page 61 of the Maya Codex *Tro-Cortesianus*, showing vessels which may contain fermenting *balche* (Villacorta & Villacorta, 1977).

lived entirely on their income from brewing. Among most peoples anyone could drink *duma*, but young women of the Jo-Lou people were not allowed to do so. Among the Bai, *duma* was used in a ceremony when a man had killed his first animal, or a leopard.

Duma was also distilled to make a spirit; the Belanda-Bviri's was *sukusuku*, the Jo-Lou's *aragi*, and Belanda-Bor's – made only by women – *siku*.

Honey added to other alcoholic drinks, including 'beer'

In different parts of Africa (Figure 48.4a) honey was added to sweeten other alcoholic drinks, or to restart or increase fermentation. Seyffert (1930) gave many examples, including beer made from millet by Marghi and Bassari peoples, from barley in Darfur and from maize in Bihd; sometimes the grain was referred to as malted. Honey might be added similarly when making wine from palm sap, or from fruits (especially banana) or their juices.

48.5 Honey-based drinks in the Americas

The Maya in Mesoamerica, who kept stingless bees in log hives (Section 30.2), made *balche* by fermenting a mixture of honey and water to which had been added bark* of a leguminous tree called *balche* native to Mesoamerica, variously referred to as *Lonchocarpus longistylus* and *L. yucatanensis*. (A *balche* extract was also used as a narcotic; the tree is the source of an alkaloid in the same chemical group as nicotine, quinine, morphine and caffeine.) Figure 48.5a shows a drawing in *Codex Tro-Cortesianus* which may represent *balche*-fermenting vessels (Deal, 1982). According to de Landa (1566), the Maya 'make wine skins of themselves, [they have such a] passion for wine that they are lost because of it'; he did his best to stamp out *balche* drinking. In recent times, the drink *balche* was made by pounding pieces

*According to an 1884 translation, Bishop Diego de Landa's *Relación* of 1566, written soon after the Spanish conquest, referred to *balche* root. This was later amended to bark by Tozzer (1941).

of the bark – or sometimes root – with sticks, and adding it to a honey-water mixture. This was tasted after 3 days to find out whether it was 'good'; if not, more honey was added, and it was allowed to stand until its colour became golden yellow.

In quantity, *balche* was a powerful purgative; it purified and cleansed those who drank it, in that it caused them to void any intestinal worms. The ultimate purpose of drinking it was to heighten religious experience, and to bring the drinker into closer communion with his gods. It was also used as a medium for administering unpleasant medicine (Ronnenberg, 1978). Much *balche* was drunk at bee ceremonies (Sections 30.22 and 30.23), and McGee (1990) described a religious '*balche* ritual' in 1980 which was not connected with beekeeping activites.

In South America maize and manioc (cassava) were the most important materials for alcoholic drinks. Others – sweet plant products or stingless bee honey – were used only where neither maize nor manioc was grown. According to Cooper (1963), this use of honey south of the Maya region was 'widespread though far from universal in a great crescent belt, more or less marginal to the southern Amazonian watershed, extending from the south-eastern Brazilian coast' through the Chaco to eastern Bolívia. Possibly honey was not plentiful enough for the purpose in most areas, but it was used by a number of Tupí-Guarani, southern Gê, Botocudo and Charrua, as well as Chaco peoples. Schmidel (1599) recorded it among the Cario (Guarani), and there are a few other early references.

Most plant materials were masticated before fermenting them, so that an enzyme in the saliva converted starch into sugar, but this was not necessary with honey combs. The drink was probably produced from them by a short fermentation, and was more similar to African 'honey beer' than to European mead. For instance Chaco peoples, who were very fond of it, mixed honey and water in a large calabash and heated it in the sun or by a fire. But they rarely had enough honey to make much.

Honey was also used to make fermented drinks from other materials, for instance various fruits and plant sap by Caribbean lowland peoples, and maize meal or manioc by the Siriono in eastern Bolivia, who kept the drink for three days until it had fermented to the strength of beer. The Caingang in Brazil consumed excessive amounts of their drink during a funeral ritual. Lévi-Strauss (1966) quoted a report that these people added an infusion of the woody stem of a fern *nggign*, because without it 'the honey would not ferment'.

Honey was sometimes added to fermented drinks made from the other materials, to sweeten them (Steward, 1963).

48.6 Honey-based drinks in Asia and Australia

Section 48.2 refers to *mádhu*, the Sanskrit word for both honey and mead, and to the common occurrence of this word in the ancient *Rig-Veda*, a Sanskrit text of an Aryan-speaking people. Otherwise, there is little to suggest that honey was fermented to produce an alcoholic drink in the south part of Asia east of

Figure 48.6a The magic fountain in the Court at Karakorum, dispensing mead and other drinks (painting from a 1715 copper engraving, Mongolian Museum).

Persia. Alcoholic drinks in general were not important there, as they were in Europe. *Sake* was an alcoholic drink made from rice in Japan. In areas converted to Islam, any previous production of alcoholic drinks was suppressed; these areas included almost the whole of western Asia to about 50°N and 80°-90°E (excluding India and Sri Lanka), and what is now Indonesia.

In northern Asia, William Rubruk's account of the Mongolian court at Karakorum in 1253/54 mentioned pipes that poured out wine, *koumiss* (fermented mare's milk), *bal* (mead) and rice wine from a magic fountain (Franck & Brownstone, 1986); see Figure 48.6a. A few years earlier Friar John of Plano Carpini had explained to King Louis IX of France that 'they do not have wine, ale or mead unless it is sent or given to them by other nations'. He also described the manoeuvres by which the fountain was worked (Dawson, 1955).

It is likely that Aborigines in Australia rarely made alcoholic drinks from honey. In the Nullarbor Desert in Western Australia, flowers of *Grevillea excelsior* were picked and crushed, and the nectar shaken into water in bowls made out of wirras (galls on *Hakea multilineata*); the liquid was left to ferment for 24 hours and then drunk (Main & Guest, 1967). I have heard that in some places in New South Wales a mixture of honey and water was fermented to produce *poull*, said to be the favourite drink and to make partakers 'quite intoxicated'.

48.7 What determined whether honey was used to make alcoholic drinks?

Previous Sections show that alcoholic drinks based on honey were important in certain regions: Europe north of the vine-growing areas; much of tropical Africa; one relatively small area in Mesoamerica, and another in South America. The drinks were of little or no importance in certain other regions where honey was available: the Mediterranean and southern Europe after vines were grown there; parts of Africa and Asia under Islamic influence; also the large part of Asia with Asian honey bees, except for an Aryan people in the very early times of the *Veda*; and finally among Aborigines in Australia.

Human physiology may provide a clue as to the reason for abstention from alcohol by some peoples. Ethanol, the alcohol produced by the fermentation of sugars, is metabolized by an isozyme (enzyme) aldehyde dehydrogenase, ALDH. The pattern of isozymes is not the same in all human races, perhaps as a result of genetic variation, and if a person with a deficiency of ALDH I consumes alcohol he experiences unpleasant or harmful symptoms, which are likely to lead to an aversion to alcohol. A few races have been tested for ALDH I isoenzyme, and Goedde and Agarwal (1989) reported that the following percentages of tested populations showed a deficiency of it. Figures in brackets were published by the Chinese Institute of Genetics in 1995.

Europe/Africa	
European (Caucasian, white)	0
'black' (Kenya, Liberia)	0
Americas	
3 North American Indian populations	2-5%
3 South American Indian populations (west coast)	41-43%
Asia	
2 Korean	25%, 27% (20%)
Mongolian	30% (30%)
Indonesian	39%
Japanese	44%
Han Chinese	45% (50%)
Vietnamese	53%

The percentages suggest that, whereas native populations of Europe and Africa would be attracted to alcohol consumption, those of eastern and south-east Asia would not. In the Americas only small samples were tested, and the situation is not clear; no information was found about the Maya, Australian Aborigines, or Aryan peoples descended from those who compiled the *Veda* – who might well react similarly to Europeans.

49

History of the Uses of Beeswax

49.1 Properties of beeswax on which its uses were based

During their evolution, honey-storing bees developed glands which secrete beeswax; this is plastic at temperatures from about 32° upwards, and the bees manipulate it into a comb structure solid and strong enough to support the honey stored in it. These bees lived in most regions of the world where there was vegetation (Figures 3.2a, 3.4a), so beeswax was almost universally available to man; it was also the only wax that many peoples could obtain, and from early times it was widely used for domestic, technical and ceremonial purposes.

About 700 BC, Homer recorded the plasticity of beeswax in Book XII of the *Odyssey*: Odysseus (Ulysses) King of Ithaca used it to ensure that his sailors would be deaf to the song of the Sirens on an island near the Italian coast.

> I took a large round of wax, cut it up small with my sword, and kneaded the pieces with all the strength of my fingers. The wax soon yielded to my vigorous treatment and grew warm, for I had the rays of my Lord the Sun to help me. I took each of my men in turn and plugged their ears with it.

Beeswax melts over a range of temperatures (60°-66°) which is relatively low. This made it valuable for candles and other lights, and in modelling and metal casting (Sections 49.2 to 49.4). Beeswax is impervious to water and to solutions of other substances in water: nectar and honey do not leak from one cell in a comb to another. Although beeswax can be dissolved in some organic solvents, it is relatively inert, so it was used as a protective coating and as a resist (Sections 49.5, 49.6), and also as a carrier in some pharmaceutical preparations (Section 49.71). Walker's bibliography (1983c) included uses of beeswax in the 1900s for purposes discussed in this Chapter, and also as a component of such products as lubricants, dental and veterinary preparations. Hepburn (1986) made extensive studies on the mechanical properties of beeswax.

The composition of beeswax is very complex, but that of the wax from any one species of honey bee is relatively uniform, and shows only minor differences from waxes of other species (Figure 52.9a). The wax discussed in this Chapter was usually from *Apis mellifera*, but in eastern Asia it was from Asian *Apis* species, and in the American and Australian tropics from stingless bees. Section 46.7 describes how beeswax was prepared from combs taken out of a bees' nest or hive.

49.2 Beeswax burned to produce light or fire

49.21 Sources of light

Waxes are flammable. If a cellulose fibre core (wick) is embedded in a wax cylinder to absorb molten wax, and the upper end of the wick in contact with air is ignited, it burns with a steady flame. Unlike mineral waxes, organic waxes such as beeswax leave no residue after burning.

The oil lamp, a shallow vessel holding both oil and wick, is known from European Palaeolithic sites. But beeswax candles needed no pottery vessel, and early evidence of them is provided by tomb paintings made during the New Kingdom of Egypt (1567-1085 BC). These show candles of two types (Figure 49.2a) which may not have had a wick. A socketed candlestick for a cylindrical candle, from about 1600 BC, was found

Figure 49.2a Candles in the Egyptian New Kingdom, 1550-1075 BC (Murray, 1963). *left* Twisted candle held by a priest. *right* Man carrying a flat candle.

in the Palace of Minos in Crete (Singer *et al.*, 1954/58).

Antipater of Thessaloniki in Greece, who lived about 15 BC, wrote of the 'wax-robed candle, the rush-lamp of Kronos, formed of the pith held together by a strip of thin bark' (*Anthologia Graeca* VI.249). The thin bark may refer to a practice known also from Ancient Egypt, of binding the candle with narrow bands of combustible material to prevent it falling apart. In Rome, the Younger Pliny (c. AD 100) described lights made by dipping partly peeled rush pith into wax, and also candles in which threads of flax were coated with pitch and wax. Candles were burned at funerals, and there have been many references to other uses. A fragment of a candle about 12 cm in diameter, from the first century AD, was found at Vaison near Orange in southern France. Many inscriptions from the AD 400s, for instance at Rome and Aquileia, clearly refer to wax candles, and mosaics at Enna in Sicily and Carthage in North Africa show them.

Farther north in Europe beeswax candles were widely used, and Bull (1970) gave many German references; cheaper tallow candles were made from hard animal fats. In England during the reign of Alfred the Great (871-899), the passage of time was recorded by equal marked divisions on a beeswax candle of specified weight; three divisions were burned through in one hour (Cowan, 1908).

In early days servants made the candles, but in the 1100s wax chandlers emerged as independent craftsmen who processed and sold beeswax, and made and sold candles and other beeswax products. The wide variety of beeswax lights used during and after the Middle Ages can be appreciated from documents held by the Worshipful Company of Wax Chandlers in London (Dummelow, 1973).

- Trindle/tryndelle: a roll or coil of beeswax taper, used for light in mediaeval churches (see also Figure 54.4b).
- Pricket: hollowed out at the bottom for impaling on a spike or pricket. (Socketed candlesticks were known in England in the 1300s.)
- Sise/size: small round candle.
- Book candle: used in a spring-loaded socket to keep the flame at reading height.
- Percher or Paris light: tall candle placed on a shelf or perch (or altar).
- Taper: made by impregnating fibrous material with either beeswax or tallow; this type had also been used in Ancient Egypt.
- Torch or flambeau: used out of doors, and usually a thick twisted tow or cotton wick soaked in resin and coated with beeswax, which could burn fiercely even in wind and rain. In a procession it was carried on a wooden staff. When the Queen of Richard III died in 1394, 'an abundance of wax was sent from Flanders to make flambeaux and torches'. (A link, used for lighting people in the streets, was made of pitch and tow.)

In the early 1500s, a Lady of Honour to Catherine of Aragon was allowed each day 'at our chandlery bar in winter, every night one pricket, and four sises of wax, with eight candles, white lights and one torch'.

When cylindrical candles came into use they were made in several ways. These included: dipping a wick and drawing it through melted wax; repeatedly rolling a wick in soft wax, adding layer on layer to it; pouring melted wax on the wick; using a mould with the wick already in place. Wicks were of twisted cotton, flax or hemp, and the beeswax had been purified so that it gave the best light and the least smell; it might also be bleached to improve its appearance. Some of the processes in 1749, shown in Figure 49.2b, are probably similar to those in earlier centuries. Dummelow (1973) described the operations.

In the Americas, wax from stingless bees was used for lighting, probably by the Spaniards from the 1500s, but apparently not by the Maya (near end of Section 30.22); the Botocudo near the Brazilian coast made beeswax torches (Métraux, 1963).

Section 54.42 examines the part played by beeswax candles in the Christian Church. Special candles of darkened beeswax were burned at funerals and masses for the dead. Very large candles were also used, including caustykes and (square) quarreres. Figure 54.4b shows a French trindle for use by a widow.

49.22 Incendiary devices

Beeswax seems to have been a common component of incendiary weapons in some regions, and Partington (1960) quoted records from the Middle East, India and China. For instance, during the siege of Jerusalem in 1099 (the First Crusade), the Muslim defenders threw at the advancing Christians incendiary devices which included pitch, beeswax, sulphur and tow. In 1097 and 1147 the Muslims used beeswax in various other mixtures. During the 1200s, incendiary grenades or fire-pots were carried on lances; they were filled with mixtures including saltpetre, and covered outside with tar, beeswax, naphtha, sulphur, etc.

The Sanskrit text *Arthashastra*, which reached its present form around the AD 100s, gave recipes, prob-

Figure 49.2b Making candles by hand, London, 1749 (Dummelow, 1973). See text (p. 525).

ably mediaeval, for two inflammable mixtures which included beeswax, for hurling at the enemy. China was the most advanced country in such military devices, and a French Jesuit missionary named Amiot compiled a treatise in 1722 which quoted Chinese sources from about 1000 to 1600. He described a device used in a siege or a naval combat: 'A paper globe covered outside with resin, oil and yellow wax is filled with powder mixed with resin and metal scrap; it is set on fire and thrown at the enemy.' The book gave detailed recipes from 1628 for incendiary balls including a 'poison smoke ball' with oxides of arsenic and poisonous plants – which were thrown by catapult.

49.3 Beeswax in modelling

49.31 Cult objects

Ransome (1937) cited an example of magic beeswax figures made in Egypt by Aba-aner in the 3rd Dynasty, about 2830 BC. From the 9th Dynasty (*c.* 2150 BC) or earlier, beeswax models were made of divinities, humans, mammals, birds, reptiles, insects (scarabs) and some inanimate objects such as ships; Raven (1983) and Ritchie (1993) illustrated many examples. Figure 49.3a shows an Egyptian beeswax *shabti*, a small model of a human figure placed within the wrappings of a mummified body, to carry out tasks for the deceased.

In regions with stingless bees, many early peoples used their wax for modelling. Figure 49.3b shows two sacred objects of beeswax in the South Australian Museum, made by Aborigines; others were realistic models of kangaroo, echidna, turtle, emu, dolphin, shark, flatfish and flying duck. In South America the Canella 'moulded wax into fairly accurate effigies of rheas, armadillos, tortoises, etc.', and the Guayaki made whistles from the wax; the Tupinamba at the mouth of the Amazon hunted for the bees' nests mainly because 'wax was important in their industries' (Steward, 1963).

Also in Brazil, beeswax was especially important to the Kayapó people. They believed that it was their only material continuity with their most ancient ancestors, who had lived above the sky and had lowered themselves down to earth bringing the wax with them. The *me-kutom* (Figure 49.3c) was a beeswax hat worn by a young man when he received his cere-

Figure 49.3a Egyptian male *shabti* (see text), 11.2 cm high, from the 11th Dynasty, *c.* 2000 BC (National Museum of Antiquities, Leiden).

Figure 49.3b Sacred human figures made by Aborigines from wax of stingless bees (South Australian Museum; photo: E. Crane).

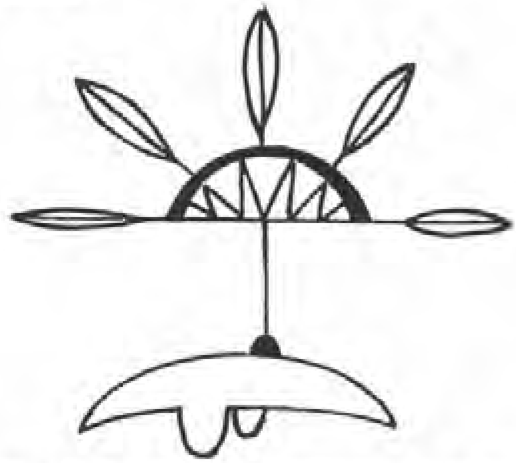


Figure 49.3c *Me-kutom*, Kayapó ceremonial hat made of beeswax, Brazil (Posey, 1983a). See text.

monial name. It was made for him by a male relative, using a ball of wax that was inherited and stored under the earthen floor of the house until needed. The form of the hat was highly symbolic. In the Figure (placed for a wearer facing right), the front and back were the poles of the morning and evening sky (east and west). The two 'legs' below were equivalent to north and south and carried painted patches representing the geographical relationship between the village (*nipok*), a raised hump in the centre, and the fields around. A stick inserted into the central hump was ornamented at the top with a woven arch of bamboo and cotton from which red and blue macaw feathers radiated; this superstructure represented the sky, and the stick symbolized the ancestors' woven cotton rope stretching down from sky to earth (Posey, 1981, 1983a).

Destructive magic

The earliest references to beeswax figures for destructive magic occur in Egyptian Coffin Texts; these were sacred writings on religious devices and magical spells, which in the Old Kingdom were the King's monopoly but in the New Kingdom appeared in coffins of private individuals. Spell 37 was to be 'spoken over a figure of the foe, made of wax and inscribed with the name of that foe on his breast ...'. The following descriptions of magic recorded during the reign of Ramesses III (1198-1166 BC) were quoted by Breasted (1962) from *Records of the harem conspiracy*.

> 454. 'He [name unknown] began to make magic rolls for hindering and terrifying, and to make some gods of wax, and some people, for enfeebl-

ing the limbs of people. .... They were great crimes of death, the great abominations of the land, the things which he had done'. He was arrested, and took his own life.

455. Penhuibin asked for 'a roll [presumably of wax] for enduing me with strength and might'; when he got it, 'he began to employ the magic powers of a god upon people. ... He began to make people of wax, inscribed, ... hindering one troop and bewitching the others. ... The great punishment of death was executed upon him.'

Museums in Cairo and the British Museum have numerous examples of 'magical' Egyptian beeswax figures.

Papyrus Salt 825 (300 BC) forbad the modelling of wax figures of enemies 'in order to kill the name of Seth', and a ritual was enacted daily, at fixed hours, in which proscribed wax figures were destroyed (Papyrus Bremner-Rhind, c. 311 BC).

Similar wax figures were made in Assyria and Babylon, and in Greece and Rome. Plato (427-347 BC) referred to 'images of moulded wax at doorways, or at points where three ways meet, or it may be at the tomb of some ancestor', which made men 'view one another with dark suspicion' (XI.933b). Ovid referred to them in *Heroides* (VI.91). In Central Europe they were still made during the Middle Ages, although the Christian Church strongly disapproved (Ransome, 1937; Fife, 1939): in 1219 Archbishop Gerhard of Bremen excommunicated people who made them, and in 1233 Pope Gregory IX threatened with eternal damnation every magician who did so.

Many votive offerings were also made of beeswax, especially in the Christian Church; see Section 54.41.

49.32 Models in art and science

In Roman times beeswax effigies were made for funeral rites. According to Pliny (AD 23-79): 'The first person who modelled a likeness in plaster of a human being from the living face itself, and established the method of pouring wax into this plaster mould and then making final corrections on the wax cast, was Lysistratus of Sicyon' (*Naturalis historia* XXXV.44.153). 'Wax models of faces were set out each on a separate side-board, to furnish likenesses to be carried in procession at a funeral in the clan, and always when some member of it passed away, the entire company of his house that had ever existed was present' (XXXV.2.6).

The production of funeral effigies of important people continued in Europe during mediaeval and later periods. In England, wax effigies of Tudor and Stuart monarchs from the time of Henry III (1272) were carried in their funeral procession and then lodged at Westminster. Those of Edward II (1327) and Charles II (1685) can still be seen in Canterbury Cathedral.

From the 1500s onwards, and especially in the 1700s and 1800s, life-like wax models were made as works of art, and for scientific purposes. Reilly (1953) described many portrait waxes in European countries, and Hansmann and Hansmann (1959) illustrated others. In science, intricate wax models were used to demonstrate external and internal human anatomy and obstetrics, and also for instance the structure of plants and fungi. The *Proceedings* of the First Congress on Ceroplasty in Science and Art, held in Florence in 1975 (Congresso Internazionale ..., 1977), are a rewarding source of information. The Specola in Florence University has a large collection of wax models, and Crane (1983a) listed other collections.

Methods of making the models have not changed for the past two hundred years; the wax used is three parts of beeswax to one part of Japan wax, produced from the pulp of *Rhus saccedanea* drupes. Marie Tussaud, née Grosholtz (1760-1850), served an apprenticeship with her uncle in Paris, and after the French Revolution had to attend the guillotine to take death masks from severed heads. She went to England in 1800 and toured Britain with her life-size wax models of famous people; wax was, however, used only for the parts of a figure that would be visible. Leslie and Chapman (1978) published a biography, and the models at Madame Tussaud's in London were described by E.V. Gatacre and J. Fraser in the 1977 *Proceedings* (above). Sargant (1971) explained how the models were produced. A plaster cast, made from a clay model, served as a mould for the wax head; the hairs were inserted one by one with a special tool, while the wax was slightly softened under a strong light.

Figure 49.3d shows the beeswax head of an Egyptian girl 14 years old, recently reconstructed from a mummy (David & Tapp, 1984). Her wrappings belonged to the Graeco-Roman period, about 800 years after her death.

49.33 Sealing wax and seals

The Romans first used wax for seals on deeds and legal documents, making a wax impression from a metal or other stamp. Sealing wax consisted of beeswax – either alone or with the addition of Venice turpentine – or, later, two thirds beeswax and one

Figure 49.3d Head of mummy no. 1770, reconstructed in wax, with wig, eyelashes and glass eyes (photo: The Manchester Museum, University of Manchester).

third resin. In England, shellac (a secretion of the lac insect) was first imported in the 1600s, and it then replaced the resin; this mixture is still used. Except for routine documents, a colorant might be incorporated: for instance green (coloured with verdigris) for documents sent to sheriffs, or scarlet (coloured with vermilion) for diplomatic purposes.

Not all sealing wax was what it was supposed to be. In the 1500s John Roberts was fined 20 pence 'for making of Ill Red Wax for seales' (Dummelow, 1973). Hepburn (1992) drew attention to falsifications brought to light by analyses of mediaeval waxes carried out in London in 1913. For instance an impression of the Great Seal of 1350 consisted of pure beeswax, but a seal from 1399, and another from 1423, 'possessed the character of East India rather than European beeswax'. (These dates would be surprisingly early for beeswax of Asian honey bees to have reached England.)

At least one wax chandler, a woman, specialized in sealing wax. Her trade card in 1778 was headed:

Superfine Sealing-Wax made by
Hannah Jones Wax Chandler
LONDON
at the Star & Garter in the Poultry.

49.34 Comb foundation for hives

From the mid-1860s, an increasingly important use of beeswax was the manufacture of comb foundation (Section 43.2). Beeswax sheets were pressed between two flat surfaces (wood, metal or plaster of Paris) which had been incised with the pattern of the bees' hexagonal cells. From 1873, the process was speeded up by passing a continuous sheet of beeswax between two incised rollers. Walker (1983b) cited publications from seven countries on the making of comb foundation.

49.4 Beeswax in metal casting

The earliest way of casting metal was to pour the molten metal into an open stone mould that had been hollowed out to receive it. Much better moulds were obtained by first making a model, usually of clay or wax, and forming round it a mould in several pieces which could be lifted off by hand after they had received the impression from the model. The pieces were reassembled to make a mould into which the metal was cast.

49.41 The lost-wax casting process

A later and more elegant method of casting metal was the lost-wax process, for which beeswax was the most common medium. Societies using this technique needed an assured supply of beeswax from hives or natural nests.

In the lost-wax process (also referred to as waste-wax or *cire-perdue*), a model was first sculpted in beeswax, and coated with pliable clay or another suitable material to form a mould. This was hardened by drying in the sun or by some other means. Next, the whole was heated so that the wax of the model melted and was drained out or 'lost' through one or more vents. (In all other casting methods, the mould had to be opened to remove the model.) To make the casting, molten metal – usually copper, bronze, brass or gold – was poured in through an opening at the top of the mould and allowed to solidify, after which the mould was chipped away and discarded. This method was mostly used for small objects, which were cast solid. If a larger object was required, a hollow casting was made. The model was

Figure 49.4a Two views of the copper 'Ibex sceptre', 27.5 cm high, c. 3500-3000 BC (by courtesy of the Israel Antiquity Authorities). This is one of the earliest lost-wax castings known. The decoration comprises four ibex heads and the head of a goat with twisted horns.

a layer of beeswax on a prepared solid core or nucleus; this layer (and the cast metal that replaced it) might be 5-18 mm thick. The greater the amount of wax in a model, the more distortion or cracking was likely to occur as the wax cooled.

A large casting of good quality could be made only by the lost-wax process, which faithfully transferred to the metal every detail sculpted on the surface of the original model, via the mould. Also, an undercut feature or a loop could be made only by this method, and may serve as an indicator that a particular piece was produced by lost-wax casting.

49.42 Lost-wax casting in lands east of the Mediterranean

Some of the earliest examples of castings made by the lost-wax process were in a hoard of ornamental copper objects found in a cave at Nahal Mishmar in the Judean desert, dated to between 3500 and 3000 BC (Misch-Brandt, 1996). Figure 49.4a shows one of many elaborate castings from this site, which were described by Bar-Adon (1980). Bagley (1987) pointed out that use of the lost-wax process encouraged the metal caster to create objects with an intricate shape. He showed an example only 7 cm high from Sumer in Mesopotamia dated to 2500-2250 BC, which represents a cart drawn by four wild asses with its driver. Beeswax was mentioned in written records from the later Assyrian Empire farther up the Tigris valley. The *Chicago Assyrian Dictionary* quoted the phrase: '20 minas of beeswax given to ——— the smith, for the production of ———'; according to Büll (1959, Vol. 1, p. 94) this wax must have been for lost-wax casting, and he dated the record to the first millennium BC.

In the early 2000s BC bronze was cast by the lost-wax process in Troy near the Aegean coast of Asia Minor, and at Poliochni on Lemnos (Ch. Boulotis; see Nikiti, 1996).

49.43 Lost-wax casting in the rest of Asia

We do not always know which of the honey bee species produced the wax used in different regions and during different periods. The lost-wax process was used between 2500 and 1700 BC in the Ancient Indus valley civilization, and after 300 BC higher up the valley in Taxila (Dani), 1989), where Alexander halted in 326 BC and which subsequently remained under Greek influence. In southern India and Sri Lanka it formed part of the revival of metal sculpture in the Chola period around AD 1000.

China had abundant supplies of copper and tin. In the Yellow River basin between 1600 and 100 BC, thousands of great ornamented bronze vessels were produced by using section moulds, but lost-wax casting was rather rare in China. It was practised by about 500 BC, and Figure 49.4b illustrates the high quality achieved. (In Jiangchuan county, Yunnan, a representation of a bee was found on a 'sacrificial bronze dorsal helmet' in a tomb dated to between 770 and 221 BC; Tian Xue-Jun, 1995.)

In the Red River basin in northern Vietnam, metallurgy started between 3000 and 2000 BC and culminated about 500 BC with the lost-wax casting of large decorative Dong Son bronze drums. Many bronze ornaments such as anklets and bracelets, made by the lost-wax method, have been excavated in Non Nok Tha and Ban Chiang in north-east Thailand (Times, 1988).

In 1992 I watched lost-wax brass casting by hand in Nepal, in a family workshop in Patan; almost all the work was done by women sitting on the ground. Michaels (1988) described the processes used there for making a number of castings from the same sculpted model.

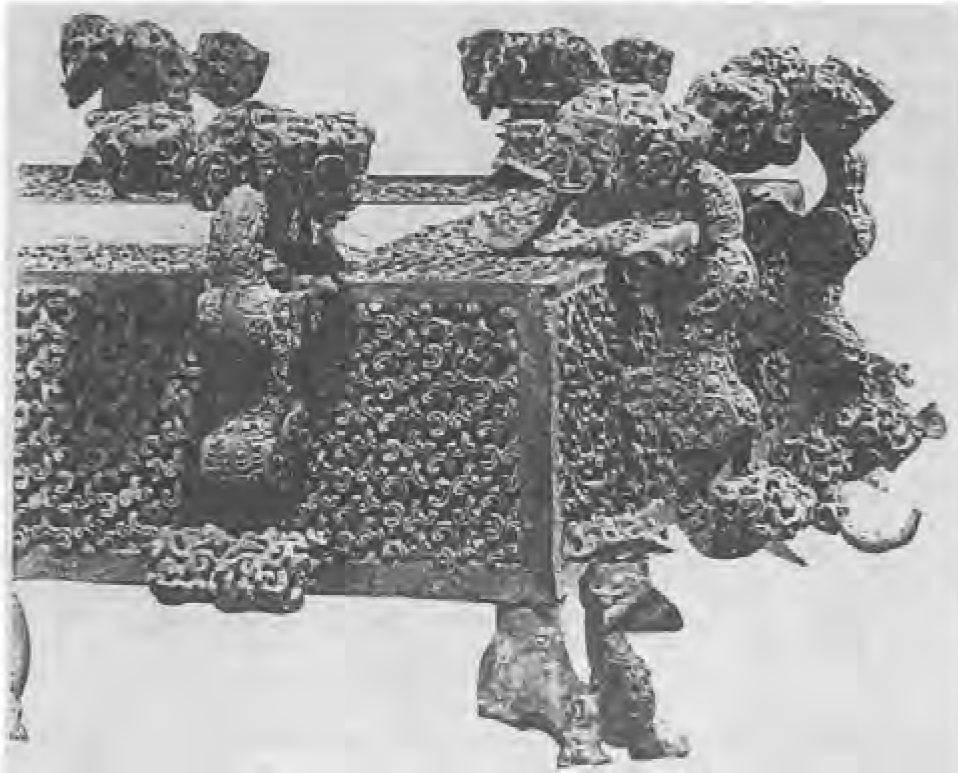


Figure 49.4b Part of a bronze altar table, 131 x 68 x 29 cm high, made by the lost-wax process, Xichuan county, Henan, China, before c. 550 BC (Henan Cultural Relics Research Institute).

Figure 49.4c Beeswax model (72 cm) of Perseus with the head of Medusa, made by Benvenuto Cellini in 1545 before he started the large statue (Property of Museo Nazionale del Bargello di Firenze).

49.44 Lost-wax casting in Europe

In Greece the lost-wax process was brought to a high state of proficiency; from the 300s BC a head was modelled, perhaps in clay, and the outer mould was formed in the usual way. The mould was then lined with a 5-mm layer of wax, and a core was inserted so that a hollow casting was produced (Singer *et al.*, 1954/58).

Several Renaissance sculptors described their procedures and the difficulties they encountered in making large statues. Benvenuto Cellini in Florence wrote a detailed and lively account of casting a great bronze statue of Perseus. It occupied him from 1545 to 1554, because of the difficulties with such a large statue (see Cellini, trans. 1956); Figure 49.4c shows his small preliminary model.

In the 1000s or 1100s weights of metals relative to beeswax had been listed, to help foundries to calculate the amounts of different metals to melt for casting (Singer *et al.*, 1955/58). In 1687, John Weichard Valvasor explained how he worked out the quantity of metal needed for a large statue. He weighed a piece of the wax, and also a lump of metal he had cast from it. 'I thereby computed the Proportion of the weight of the Metal and the Wax, and then, observing how many Pounds of Wax I use about the

Figure and Channels, I can calculate to a small matter how much Metal I need to melt' (Savage, 1968).

49.45 Lost-wax casting in Africa

In Ancient Egypt, the lost-wax process was practised from the 18th dynasty at the start of the New Kingdom (Savage, 1968), about 1567 BC, and continued until Roman times. Leek (1975) showed a small beeswax model of a falcon, and one of a heron found in the golden shrine in Tutankhamun's tomb (c. 1340 BC).

The following regions among others had a tradition of lost-wax casting of bronze (actually brass) from the period indicated.

Igbo-Ukwu in southern Nigeria	AD 800s
Ife in eastern Nigeria	900s
Lake Chad area	1100s
Benin (see below)	1400s
Lower Niger	1400s
Ghana, Ivory Coast	perhaps 1400s
Dogon, Senufo, Fon	dates uncertain

The earliest of the bronzes are naturalistic castings which show a very high degree of skill in the lost-wax process, and their sculptured form seems to have come fully developed from terracotta sculptures (Shaw, 1970). As a result of these and other finds, Shaw concluded that 'we ought not to be surprised to learn that Africans south of the Sahara seem to have discovered the art of lost-wax casting for themselves'.

Use of the technique continued in a large region, from Chad in the east to Senegal on the west, and it is still strong in West Africa. Benin (an important city and kingdom from 1250 to 1897, now in Nigeria) learned it from Ife, and the court art of Benin became world famous, especially its large bronze castings.

Ashanti people, in what became the Gold Coast and later Ghana, worked and traded in gold before the time of Herodotus (400s BC), who commented that 'they possess a complete set of weights and scales ... these weights are of great antiquity'. From perhaps AD 1400 Ashanti gold dust was weighed against tiny 'gold-weights' made by lost-wax casting of copper, bronze or brass into the shape of animals and other figures; Moody (1979) showed examples, and Crane (1983a) gave other details.

49.46 Lost-wax casting in the Americas

In regions where gold was found, and wax from stingless bees was available, this was used for lost-wax casting of gold ornaments and jewellery before the Spanish conquest. In South America, the most expert gold casting in what is now Colombia was done by the Tairona at the foot of the Sierra Nevada de Santa Marta, the Quimbaya and Calima of the upper Cauca, and the Sinú of the hills south of Cartagena (Bennett, 1963). Gold castings of the Muisca (or Chibcha), who had to obtain gold by trading, were less fine. Enormous quantities of gold objects were found and taken by the Spanish. Captain Francisco César reported from the middle Cauca valley: 'Digging in a certain place they found a vault ... [containing] many pitchers full of jewellery of very fine gold, all of it of 20 or 21 carats. It amounted to over 40,000 ducats.' There are many such records.

The art of lost-wax gold casting spread northward from South America, and it reached the area which is now southern Costa Rica, where there were also gold deposits, by about AD 500. However, most of the objects which have been found there are dated to between 1000 and 1500. The Mixtec developed the method in the Mexican metallurgical centre of Oaxaca between about 1350 and 1500, and Fray Bernardino de Sahagún recorded it in detail in the 1500s. He said that the goldsmiths especially esteemed the (stingless bee) beeswax; they mixed it with white copal (a resin) so that it would become firm and harden well, and cleaned it by straining to remove dirt and other impurities.

In what is now Mexico, the Aztec Emperor Montezuma presented Cortés with many gold objects, described by Bernal Díaz in 1519. They included '20 ducks made of gold, very natural looking, and some dogs of the kind they have, and many pieces of worked gold shaped like jaguars, lions or monkeys'. Albrecht Dürer, who was the son of a goldsmith, saw these treasures after they reached Europe, and is said to have exclaimed: 'Never in all my life have I seen things that delighted my heart as much as these. For I saw among them amazing artistic objects, and I marvelled at the subtle ingenuity of the people of those distant lands' (Hemming, 1978). These ornaments were almost certainly cast by the lost-wax process.

Apart from one curious report from the north of Colombia quoted by Simón (Section 30.51), the most southerly known occurrence of hive beekeeping with stingless bees in or before the 1500s was in the Nicoya peninsula of Costa Rica. It thus seems likely that all or most of the wax used for gold casting in the Americas came from nests in trees. Many gold works of art were produced in Peru during the Inca Empire between the 1450s and 1530s, but most were melted down by the Spanish, and I do not know how they were made. However, there are many thousand

examples in the Gold Museum in Bogotá, Colombia, and the Pre-Columbian Gold Museum and National Museum in San José, Costa Rica. In Costa Rica, larger gold ornaments were made on a core which was later removed, because the ornaments would otherwise have been too heavy to wear; the Spanish chronicler Simón (1626) said that 'they were ornaments exclusively for men, just as among us they are for women'.

49.5 Beeswax applied to solid surfaces

49.51 Beeswax as a surface finish

Beeswax has been found in recent excavations of two very early European sites. It was identified in a shiny black layer on the inner surface of a small bodysherd from 3700-3340 BC, found in a Neolithic settlement of the Altheim culture in Bavaria (Heron *et al.*, 1994), and also on sherds in England dated to 3000-2650 BC (Section 9.43).

Beeswax was a primary ingredient in polishes and other finishing preparations for a variety of surfaces: wood and leather; marble and stone; textiles and baskets. It is inert and impervious to water, and rubbing it on a surface gives this a smooth shiny appearance.

For a protective and glossy surface finish to marble, stone and plaster, Romans used Punic (Phoenician) wax, made in Carthage from beeswax:

> which is exposed to the wind several times in the open, then it is heated in water taken from the open sea, to which soda has been added. Then they collect with spoons the 'flower', that is, all the whitest parts, and pour it into a vessel containing a little cold water. Then it is boiled again by itself in sea water, after which they cool the vessel itself with water. When they have done this three times, they dry the wax in the open, by sunlight and by moonlight, on a mat or rushes. For the moon makes it white while the sun dries it; to prevent the sun from melting it, they cover it with a piece of thin linen cloth. The greatest whiteness, however, is obtained if after the exposure to the sun the wax is once more boiled again.' (Pliny, XXI.49.84)

When the protective process (*ganosis*) was applied to a wall, the plaster was allowed to dry and then coated with Punic wax melted with olive oil, and applied with brushes of bristles while it was still hot. This wax coating was heated again, by bringing near it burning charcoal made from plant-galls, until it exuded drops of perspiration; the surface was then smoothed with waxed rollers and finally with clean linen cloths, 'in the way in which marble is given a shine' (Pliny, XXXIII.122).

In Roman times a polish for wood was made by mixing oil of juniper or cedar with beeswax. From the 1100s to the 1300s, wooden furniture was often polished with beeswax only – for instance in monasteries – and for new wood the wax was heated and poured on, so that it penetrated a few millimetres. In later centuries, turpentine was added instead of oil or, by Chippendale's time (1700s), linseed oil with a little crystallized pine resin dissolved in alcohol. Shellac gave a harder product known as French polish.

When hard paraffin (mineral) and carnauba (plant) waxes became available in the late 1800s, beeswax lost its dominance in polishes. C.L. Jones (1977), a polish technologist, gave details of this final substitution and said that 'the use of beeswax in early polishes was accounted for by its availability, and mainly because it resembles in many respects the more balanced wax formulations arrived at by polish technologists which give films that can be buffed to a gloss, but are soft and easily marred'.

Polishes for leather were rather similar to those for wood, and in many of them a harder wax, with oil and (later) turpentine, were mixed with the beeswax. Lampblack or another dark pigment might be added, and sometimes pitch or tar. In the Middle Ages beeswax was used to waterproof moulded leather armour known as *cuir bouilli* (Waterer, 1981), and also the interior of moulded leather containers for liquids. Paris ordinances of 1475 and 1560 insisted that *new wax* should be used to line the interior of leather bottles, to ensure that they did not impart a bad taste to the contents. In many parts of the world, close-woven baskets of fine fibres were coated inside with beeswax so that they would hold liquids; I have a milk container made of grass fibres which has such a lining, made about a hundred years ago in Kenya.

In South America various peoples used wax from stingless bees to fill cracks in pots, to seal corded bags and gourds holding next year's seed corn, as well as to coat the interior of baskets, including honey containers; the wax was sometimes mixed with charcoal (Steward, 1963).

In 1992 I found that beeswax was used for textile finishing in the mountains of Lao Cai province of north Vietnam, close to the Chinese border. Mung people near Sa Pa kept bees in a very primitive way, to get beeswax to treat the cloth they wove. They

collected seeds of ramie (*Boehmeria* sp.) in the forest, grew plants from them, separated the fibres and wove them into strips 15 cm wide, from which they made all their clothes. They dyed the woven cloth with indigo from the forest, and finally boiled it in water to which a piece of beeswax had been added. This would strengthen and smooth the cloth and prevent the colour bleeding (Ritchie, 1994).

49.52 Painting with beeswax

In the north of Australia, Aborigines used wax from stingless bees (which the bees have often mixed with much propolis, Section 3.6) to paint animal and human figures on rock surfaces, as in Figure 49.5a. Nelson *et al.* (1995) obtained radiocarbon dates of about 2000 BC onwards for the medium used in eight of these paintings.

Figure 49.5a Figure of a man painted in beeswax from stingless bees, Mushroom Rock, Jabiluka area, Kakadu National Park, NT, Australia (Flood, 1983).

Beeswax from *Apis mellifera* was applied as a surface finish to wooden ships in Ancient Egypt, Greece and Rome, and Anacreon of Teos in Asia Minor mentioned the use of wax for painting about 500 BC. Around 300 BC, when Philopater was the Ptolemaic ruler of Egypt, the Greek historian Callisthenes (Aristotle's nephew) reported of Philopater's ship that 'every part was decorated with wax painting'. Pliny wrote (XXXV.149):

> In the early days there were two kinds of encaustic painting, with wax and on ivory with a graver ... , but later the practice came in of decorating battleships. This added a third method, that of employing a brush, when wax has been melted by fire; this process of painting ships is not spoilt by the action of the sun nor by salt water or winds.

The pigments included papyrus ashes, anchusa and indigo.

Wax was used in encaustic painting, described below; this reached its highest level during the early centuries AD in Fayum 100 km west of Cairo, where portraits of Greeks, Romans and Jews were made on wooden panels. A portrait was probably hung on a house wall until the subject's death, when it was cut down to fit into the mummy wrapping round the body; Figure 49.5b shows an example (for wax effigies see Section 49.32). After Socrates died in 399 BC, someone who saw his wax portrait remarked: 'Painter, who hast reproduced the form of Socrates, would thou couldst have put his soul into the wax.'

The medium and the method for these and other wax paintings were discussed in detail by Dow (1936), Laurie (1937/38) and Burdick (1938). It has repeatedly been published that the paint referred to as encaustic was applied cold and then burnt in. But Dow could find no evidence for this, from experiments or from the literature. She concluded that the paint was applied hot, and examination of a Fayum portrait revealed traces of the instruments used, including a brush and a hot bronze tool – which indicated that there was no heating after the wax was applied.

There has been some doubt as to whether natural beeswax or Punic wax was the basis of the paints (Dow, 1936). Samples of paint used in Fayum were found to have melting points higher than that of pure beeswax, which might be caused by the addition of pigments, lanolin (wool fat) or propolis. Punic wax made by the method quoted from Pliny in Section 49.51 also had an elevated melting point – listed at various values between 80° and 100° – and contained

Figure 49.5b Wax encaustic portrait of a woman from Hawara, Fayum, Egypt, c. AD 250 (Petrie Museum of Egyptian Archaeology, University College, London).

less cerotic acid. It was harder and more adhesive, so it would adhere better to a painted surface (Burdick, 1938).

49.53 Writing tablets

In Ancient Egypt, writing not sufficiently important to warrant the use of papyrus might be done on a wooden tablet covered with a kind of gesso. Later, instead of gesso, a uniform coat of beeswax was spread on a wooden surface recessed to receive it, and usually covered with a thin layer of black wax. Two such tablets were hinged together with cords to form a folder or book. The writing was done with the pointed end of a stylus, and the other end might be flat to erase errors or to clean the surface for re-use.

Figure 49.5c shows the oldest known surviving writing tablets, from around 1300 BC; Bass (1990) reported that the wax was no longer in place, but the recessed areas had been cross-hatched to improve its adhesion to the wood. Pliny referred to 'sheets of linen or tablets of wax for private documents; for we find in Homer that the use of writing-tablets existed even before the Trojan period [c. 1250 BC]' (XIII.69). Hinged writing boards of ivory coated with wax were used in Assyria before 1000 BC (Saggs, 1965). Waxed surfaces for writing are known in Egypt from the Graeco-Roman period which started about 300 BC, and in Rome Ovid referred to wooden tablets with 'wax close writ with characters' (*Amores* I.12.7).

The use of writing tablets continued until after the Middle Ages in Europe. Waxed tablets found in sev-

Figure 49.5c Pair of wooden writing tablets found in a ship wrecked around 1300 BC off the coast of Lycia now in Turkey (Bass, 1990; copyright Institute of Nautical Archaeology).

eral north German towns were inscribed with school and business exercises, and with political texts relating to the Peace of Stralsund in 1370 (Schildhauer, 1985). In 1988 a book of eight waxed wooden tablets encased in leather, only a few centimetres across, was found in York, England, and dated to the 1300s (Bedlow, 1992). The writing occupied 14 sides and included a document in Latin and a poem in Middle English.

49.54 Beeswax as an adhesive

Early peoples had very limited sources of adhesive material to join two surfaces together, and beeswax was widely used for the purpose. In Greek mythology, when Daedalus needed to escape from Crete with his son Icarus, he made wings for them both, of feathers and beeswax. He warned his son not to fly too low where the sea spray might wet them, or too high where the sun might melt them. Forgetting the second warning, Icarus soared too near the sun: the wax melted, his wings dropped off, and he fell into the sea and was drowned between the Sporades and Asia Minor.

According to Virgil, the use of beeswax as an adhesive was initiated by the Greek god Pan who 'first taught man to make many reeds into one with wax' – known as the Pipes of Pan (*Eclogues* II.32).

In Ancient Egypt about 1340 BC, beeswax was used as an adhesive, for instance to affix the lids of vases and other vessels such as those found in the 18th Dynasty tomb of Tutankhamun, and to fix the flint teeth of a sickle in place. Specimens of beeswax adhesive had different melting points, so propolis or a plant resin may have been added to them (Lucas, 1962).

The Ethnography Department of the British Museum has a number of artefacts whose components were fixed together with beeswax, and the unpublished catalogue includes one or more of each of the following.

With wax from African honey bees

- Whistle, and Hadza child's arrow from Tanzania; cross-bow from Cameroon; head mask from Mozambique; Tiv voice disguiser from Nigeria; revenge charm from Zambia.

With wax from stingless bees

- South America: flute and other musical instruments, ceremonial mask, snuff container; spear, arrow for birds, quiver, dart and blowgun from Colombia; axe, quiver, whistle and feather mask from Brazil; gouging tool made from a wild boar's tooth from Bolivia.
- Australia: head ornament of feathers, headband of kangaroo teeth, neck ornament, bangle; stone spear, axe head, stone knife and a knife of quartz, wood and kangaroo fur.
- Papua New Guinea: divining skull; head ornament of cassowary quills, seeds and cockatoo feathers.

With wax from Asian honey bees

- Knife and stringed musical instrument from Sarawak.

49.6 Beeswax as a resist

A resist is an inert substance applied to selected areas of a fabric or other surface, to protect these from an agent to be applied afterwards. Beeswax was often the only substance available for this purpose. After coating the areas with wax, fabric was dipped in a dye, or metal to be etched was dipped in an acid bath.

49.61 Dyeing textiles (batik)

Figure 49.6a shows an early example of a garment made from cloth dyed by a wax-resist method – a child's cotton tunic from Egypt found in a tomb and reported by Forrer in 1891 (Ritchie, 1993); it probably dates from the period AD 400-600. The garment is in the Victoria and Albert Museum in London, which also has a fragment of a Coptic altar hanging of resist-dyed linen from the same period (Annunciation Inv. 723-1897). Egypt did not grow cotton until AD 600-700, so the tunic may have been brought there by Indian traders.

Figure 49.6a Child's tunic of cotton, resist-dyed with indigo (drawing by I. Ritchie from original in Victoria and Albert Museum, London, no. 1522-1899). See text.

Wax-resist printing is sometimes considered to have started in India, and the following were probably among the main Old World centres of early wax-resist textile dyeing (Ritchie, 1994):

Indonesia:	on Java, Sumatra and farther east
Borneo:	on the east coast
China:	Hainan, Shantung, Xinjiang, Khotan
India:	Madras, Gujerat, Ahamabad, Coromandel coast
Uzbekistan:	Bokhara
West Africa:	Sonike and Bambara near the Guinea coast
Ukraine:	Crimea (wool, in AD 300s).

49.62 Engraving and etching

Designs had been engraved on metal in Antiquity. In the 1400s armourers in northern Europe applied a design to a metal surface by etching, which involved less work. The design was lightly engraved on the metal, and a resist (made for instance of gum, resin and beeswax) was dabbed as a coating on the surface. An acid was then applied to etch the engraved lines which were unprotected by the resist (Singer *et al.*, 1954/58); Cowan (1908) gave recipes. From about 1500 Durer and other German etchers used this procedure, and their successors did so in Austria, Italy and the Netherlands.

After 1600 the resist – a soft 'etching ground' – was spread out thinly all over heated metal, without previous engraving. The surface was blackened, and the etcher drew on it lightly with a steel point to expose the metal below, which was then treated with acid. The final great developments in pure etching were made between 1600 and 1730, especially in the Netherlands and above all by Rembrandt (Singer *et al.*, 1954/58).

Glass was etched in a similar way.

49.7 Beeswax in pharmacy, cosmetics and preservation techniques

49.71 Pharmacy

The Ebers papyrus, compiled in Egypt about 1550 BC, includes wax (which would have been beeswax) in 32 prescriptions, all for external use, but beeswax was a much less common ingredient than honey (Section 47.4). The wax was almost always used with an animal fat, variously specified as grease, or grease of ox, goat or ibex. The wax and grease acted as a carrier for a variety of other ingredients; for instance an ointment 'to soften all things' included gum, myrrh, yellow ochre, grease of ox and wax. Ointments were commonly applied warm, with bandaging. There were specific prescriptions for burns, a broken finger that had 'grown together', suppurating neck gland, embedded thorn, and wounds. Others were 'to relieve members', or to soften joints or stiffness. Weakness of the male member (impotence) was treated by applying wax, honey, northern salt, yeast fluid, and two unidentified substances.

The use of beeswax was continued in Greece and Rome, for instance by the Greek physician Galen (AD 130-201) in plasters, compresses and ointments. Pliny referred to both external and internal uses: 'All wax however is emollient, warming, and restorative of flesh; the fresher it is the better. It is given to sufferers from dysentery in their gruel, and the whole comb in a porridge of groats that had been previously roasted' (XXII.55.116). He also mentioned 'wax salves, poultices, plasters and eye-salves ...' (XXII.56.117).

Beeswax was used in medicine in many other parts of the world. According to Miles (1988), German-Hungarian women used a disc made from melted beeswax as a contraceptive cervical cap. In Slovakia, sufferers from jaundice drank from a cup made of beeswax. Items in the Shôsôin Treasury in Osaka show that beeswax was used in Japan from Ancient times, for instance in making pills (T. Watanabe & Shibata, 1955). In the Caribbean island of Guadeloupe, soft wax from stingless bees was used to make plasters for corns and for warts on the hands or face (Labat, 1722, referring to 1696).

49.72 Cosmetics

The properties of beeswax made it suitable for a wide variety of cosmetics. It is inert, does not become rancid, and is not an irritant or sensitizing agent to the skin. In Ancient Egypt, however, preparations applied to the face as a protection against the blistering heat contained oils and fats rather than wax (Lucas, 1962). Wax and fatty matter were found in remains of a few possible 'cosmetics', although not in *kohl* for darkening eyelids. Beeswax mixed with resin and aromatic substances, contained in a toilet box and a New Kingdom cosmetics jar, may have been for fixing the hair. Beeswax was always used when making wigs of hair, to ensure that the curls and plaits kept their original form.

In Greece, Galen made a cold cream of beeswax, olive oil and water. (This mixture separates out, but about 1890 it was found that added borax reacts with cerotic acids in the beeswax and produces a more stable product, which is also whiter; Coggshall & Morse, 1984.) Cosmetics were used extensively in

Rome after Nero's time (AD 68), and they were brought into Europe again from the eastern Mediterranean in the 1100s as a result of the Crusades. Beeswax became a major component of cosmetics such as skin creams, lipstick, eye shadow and mascara, as well as hair creams.

Recipes were given for instance by Cowan (1908) and R.H. Brown (1981). Proserpio's 1981 Italian book deals with cosmetic uses of beeswax among other bee products, and Walker (1983b) cited information from five other countries.

49.73 Preservation techniques

Beeswax played a minor role in the mummification process of Ancient Egypt. It was often used for covering the ears, eyes, nose and incisions through which internal organs had been extracted during the embalming process; such incision plates can be seen at the British Museum and elsewhere. A brown encrustation about 1 to 2 mm thick on the thighs and back of one female mummy from the 11th Dynasty (about 2000 BC) was identified as beeswax (Lucas, 1962), but such a beeswax body covering was not usual. Recent scientific analysis indicates that beeswax, together with resins, oils and/or bitumen, was applied to the bodies and wrappings of a number of Egyptian mummies of the Greek and Roman periods (David, 1979; Storch & Schäfer, 1985; Connan, 1991; Connan & Dessort, 1991).

Beeswax was used elsewhere in the Ancient World for preserving corpses of important men. Section 47.41 refers to an Akkadian practice in the 2000s BC of smearing a body with wax before burying it in honey. Herodotus (485-425 BC) said of the Scythians that when their King died they 'coated his body with wax' and applied preservative treatments to the interior, so that the body could be put on a wagon and carried 'around all the subject nations' before burial (IV.71). He also recorded that 'once they have embalmed the corpse with wax [literally 'having coated his body with wax'] the Persians bury it in the ground' (I.140.2). In his *Life of Agesilaus* (XL.3), Plutarch referred to the death of this King of Sparta in 360 BC.

> It was the Spartan custom, when men of ordinary rank died in a foreign country, to give their bodies funeral rites and burial there, but to carry the bodies of their kings home. So the Spartans who were with Agesilaus enclosed his dead body in melted wax [literally 'melted the wax on him'], since they had no honey, and carried it back to Lacedaemon.

Cicero (106-43 BC) made a similar comment about the Persians: 'Egyptians embalmed their dead ...; the Persians dress them over with wax, that they may preserve their bodies as long as possible' (*Tusculan Disputations* 1.45).

In mediaeval England bodies were commonly wrapped in a cering (or searing) cloth which was impregnated with beeswax to delay decomposition. Edward I of England and Elizabeth Queen of Scotland, daughter of Henry VII, were buried in cerecloths in 1307 and 1541, respectively (Fraser, 1958).

50

History of the Use of Bees as Stinging Insects

50.1 How the bees were used

Stinging (Section 33.11) is the honey bees' chief mechanism for defending their colony, and they rarely sting at a distance from their nest or hive unless they are directly attacked. A worker bee can sting after she is a few days old, when her venom gland has developed. If a bee's sting (Figure 50.1a) penetrates the human skin, venom is released and enters the wound via the venom canal. The sting is barbed, and the bee cannot withdraw it; when she tries to do so the whole sting apparatus breaks off and she subsequently dies. A stinging bee also releases 'alarm pheromone' whose scent alerts other bees to sting at the same site.

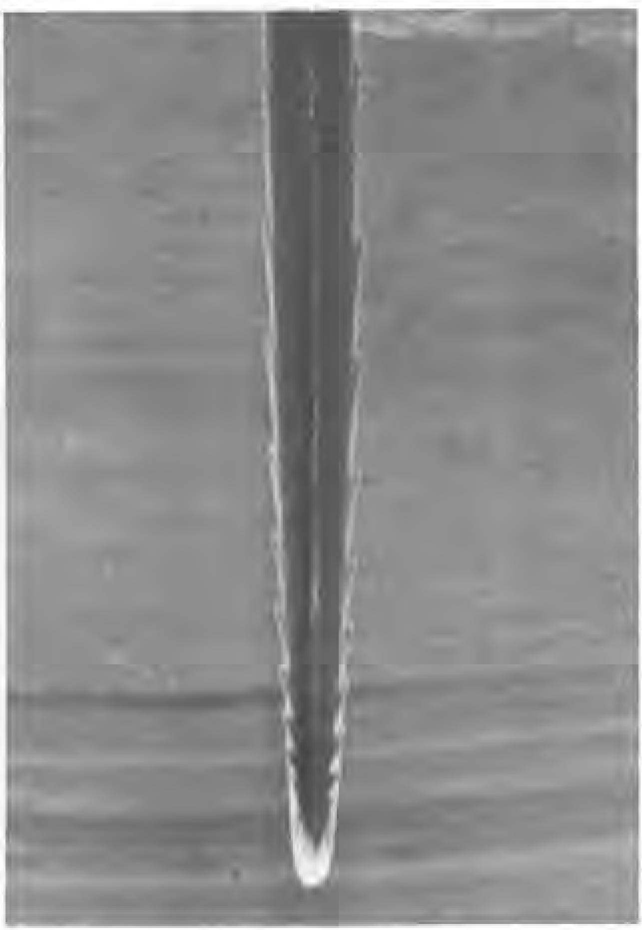


Figure 50.1a Sting of a worker honey bee (x 180) as seen through a scanning electron microscope (Erickson *et al.*, 1986). The two lancets with barbed edges lie on top of the stylet (which appears white), and the three surround the venom canal.

Figure 50.1b shows part of a drawing in the Canterbury Psalter which illustrates the concept of bees as attackers: 'They compassed me about like bees', or (NEB) 'They surround me like bees at the honey' (Psalms 118.12).

Bees have been used as a military weapon since early times. In the Ancient World they were released from hives into an enclosed space occupied by the enemy (Section 50.2). From the Middle Ages onwards in the Mediterranean region and western Europe, hives containing bees were dropped, thrown or projected at the enemy (Section 50.3), and the impact of the hive alerted the bees; these flew out and stung men or animals close by, but the person who threw the hive from a distance would be less at risk. A traditional hive might contain between 10,000 and 20,000 bees.

Figure 50.1b Illustration from the Canterbury Psalter, 1100s (published by permission of the Master and Fellows of Trinity College, Cambridge, R.17.1, f.208a).

In incidents reported after 1850 (Section 50.5) hives were not projected at the enemy; instead, there are stories of trip wires attached to hives, laid so that the enemy would activate them and disturb the bees. This system was feasible with the larger log hives in tropical Africa, or with movable-frame hives.

Section 50.3 describes punishments by bee stings in which the victim – often naked – was bound and smeared with honey before being placed where bees would have access to him or her.

I am indebted to Robert Reid for his searches which have brought to light several attested accounts new to me. Some of the incidents mentioned below were cited by Fife (1939) in his section on 'Bees in Christian warfare', and others by Bessler (1886) and Ransome (1937). It has been impossible to validate some of the reports quoted, and many others which are not included. Nevertheless I am sure that bees were used in most of the ways mentioned, even if not on all the occasions cited, or with such dramatic effects as those described. In conversations with beekeepers in various parts of Europe which had been under enemy occupation during the Second World War, I realized that it had seemed natural to them to hide small valuable items inside their hives of bees. I think it would also have seemed natural to earlier peoples familiar with bees to use these as weapons on appropriate occasions.

50.2 The Ancient World

Figure 7.3a illustrates a Greek legend in which men became exposed to bee stings when their armour fell off, and the text explains the circumstances.

Two early writers referred to releasing bees into mines (tunnels) by which an enemy intended to reach, damage or penetrate a defended position. The first was Aeneas Tacticus (*c.* 357 BC) who had been general of the Arcadian League a decade earlier. He wrote in his treatise on the defence of fortified positions: 'In some instances, by releasing wasps and bees into the opening, men have worked mischief with those in the mine' (XXXVII.4). The second was Appian, whose *Roman history* (XII.11.78) described a reverse sustained by the Roman commander L. Licinius Lucullus in 72 BC, during the Third Mithridatic War against the King of Pontus, south of the Black Sea coast. When the Roman army besieged Themiscyra (about 50 km east of Samsun on this coast), the inhabitants cut openings from above into the tunnels dug out and occupied by the Romans, 'and thrust bears and other wild animals and swarms of bees into them'. Later in the same War, toxic honey from the region was used as a military weapon (Section 47.21).

Although stingless bees do not sting, they can cause distress in other ways, and *Popul Vuh*, the sacred book of the Ancient Quiché Maya in highland Guatemala, relates the following incident. When a town of their ancestors was besieged by another tribe, the inhabitants hunted for hornets, wasps and (stingless) bees, and put them into great calabashes which they uncovered when the enemy attacked: 'And the insects flew out like smoke, flew in the eyes, noses and mouths of the enemy, hung on their legs and arms, which they stung and so obliged the men to throw down their weapons, when they were attacked and killed by the men of the town' (Schwarz, 1948).

50.3 The Middle Ages

Several versions are told of an incident dated to about AD 500, in which a leading part was played by St Gobnat who was in charge of a Christian convent at Ballyvourney in the south of Ireland. She kept bees, and used them to repel a band of raiders who were stealing the local people's cattle; she probably upset some skeps to make the bees fly out. In some versions of the story she miraculously changed the bees into soldiers, and a skep into a brass helmet which she presented afterwards to the defending chieftain O'Herlihy. His family is said to have treasured the helmet until the penal days in the 1700s (when the English proscribed Roman Catholicism), and it was then lost. In another version the skep was turned into a bell, and up to the 1800s St Gobnat's bronze bell was at Ballyvourney, with the two holes at the top for fixing the clapper; the bees were said to have come out through these holes to sting the marauders. Ransome (1937), Fife (1939) and Crane (1983a) gave further details.

In 908 invading Danes under Hingamund besieged the English in Chester who were led by Ethelred or Ethelfleda of Mercia. Danish soldiers attacking the city walls used hurdles as a protection from rocks thrown down on them, but the English then threw skeps of bees, and the Danes were stung so severely that they abandoned the siege (Ransome, 1937). In 940, when a stronghold of Otto I, King of the Franks and Saxons, was besieged by Geiselbert Duke of Lorraine, the defenders flung hives of bees out against his horsemen, and the horses were so badly stung that the attack failed. Stings seem to have made horses unmanageable, so bees were very effective against cavalry; see Section 35.21.

The 1098 siege and capture of Maara (not far from Antioch) during the First Crusade was described by William, Archbishop of Tyre, who died in 1185. The Muslim inhabitants tried desperately to drive the Christian enemy from the fortifications: 'they made use of stones, beehives swarming with bees, fire, and even quicklime' (Babcock & Krey, 1943). According to an early English translation of a French romance now lost, when Richard Coeur de Lion was on the Third Crusade, 'among the instruments of offence little known to modern warfare were beehives, which were so numerous as to occupy no less than thirteen vessels'. Richard reached the Crusader camp at Acre on the coast north of Jerusalem in 1191, and he is known to have brought stones for his siege engines (probably as ballast). He could well have brought earthenware hives of bees from Cyprus (Section 22.12) which was then in Christian hands, but thirteen shiploads seem improbable.

In 1289 Duke Albert of Austria besieged Gussing in Burgenland (now in Austria), and according to Scharl (1958) the inhabitants defended the town 'with hot water, firebrands and bee hives'.

Some references to the use of hives as military weapons have been traced back only to the 1657 beekeeping book by Samuel Purchas, for instance:

- When Amurath the Great Turk besieged Alba Greca, the citizens threw hives of bees over the walls to drive their enemies away.
- When at war with the Moors in Mauritania, Lupus Barriga besieged Tornli, whose inhabitants set hives of bees on fire and threw them over the walls.

An English manuscript on military weapons compiled in 1326 includes the two drawings in Figure 50.3a; the machine is a 'windmill' which projected skeps of bees at the enemy. On the left a knight is loading the machine, and one skep is about to leave it. On the right a skep is falling into a fort, and some knights defending this are attacked by bees (James, 1913). No other information has been found about mechanical devices for the military use of bees.

Avesnes near Maubeuge in northern France was said to have been saved in 1498 when a swarm of bees stung an attacking band of pirates, and this incident was the subject of a painting in which the Virgin Mary is shown performing the miracle.

Stinging as a punishment

The earliest reference found is from Asia Minor about 1500 BC. The Hittite law code then laid down a new penalty for stealing hives (Section 21.2), and referred to the earlier penalty in which the accused was 'exposed to the stings of bees'. According to Purchas (1657), an old man Marcus overthrew an idol temple at Arethusa during the reign of Constantine; he was taken under Julian the Apostate (c. AD 331-363), scourged on his naked body, and finally anointed all over with honey and left to be stung to death. William of Tyre, referred to above, recorded the fate of Patriarch Aimery of Antioch when he

Figure 50.3a A machine for hurling bees into a besieged fortress, 1326 (manuscript by Walter de Milemete in Christ Church, Oxford, no. 92, ff. 74, 75). *left* The machine being loaded with skeps. *right* One of the skeps arriving in the fortress.

spoke publicly against Prince Renaud de Châtillon, probably in the 1150s. Renaud 'forced the aged priest, a successor of Peter, the chief of the apostles, although an almost helpless invalid, to sit in the blazing sun throughout a summer's day, his bare head smeared with honey. No one, for piety's sake, offered him any relief from the relentless rays of the sun or tried to drive away the flies' (Babcock & Krey, 1943). It seems likely that these 'flies' were, or included, bees.

Most other records are from Europe in the Middle Ages. In England, William of Malmesbury stated that during the reign of King Stephen in the early 1100s: 'Robert Fitzhubert ... used to expose his prisoners, naked and rubbed with honey, to the burning heat of the sun, thereby exciting flies and other insects of that kind to sting them' (Fraser, 1958).

Purchas attributed to Suidas, a Greek lexicographer who probably lived some time between 500 and 1150, the information that a cozenor or cheater was anciently punished by being anointed all over his body with honey, then set in the sun with hands and feet fast bound, and left to be stung to death. Purchas also said that in Seville, Spain, a woman who beat her husband was carried on an ass through the city, naked and anointed with honey from the waist up; she 'suffered not a little misery', but did not die.

Niellim people in Africa were said to use a colony of bees to determine whether or not an accused man was guilty. He had to thrust his hand into the mass of bees, and if he was not stung he was innocent – 'but it is well understood how to stir the bees up' (1912 report, Seyffert, 1930).

50.4 From 1500 to 1850

In 1515 the Portuguese besieged the fort of Aguz near Safi on the north-west coast of Africa. The event was described in a Latin history of Portugal which was published in French by I. Osoris and others in Geneva in 1581 (Burg, 1963). Those defending the fort threw down on men climbing the walls: 'fire and an infinity of swarms of bees in which the country is rich. The Portuguese, burned by the fire and much stung by the bees, were constrained to retreat.'

Various writers have mentioned, without dates, a number of rather similar incidents in Europe, some of which may have occurred during either the Peasants' War (1524-25) or the Thirty Years' War (1618-48). Likely examples in the Peasants' War were at Hohenstein in Thüringen, and Bielsburg. The town of Stuhlweissenburg (Székesfehérvar) south-west of Budapest was said to have been saved from attacking Turks by the use of bees in 1599 (or 1602).

An illustration based on that in a 1664 book by Jacob Cats, *De ouderdom* (Old times), is reproduced in Figure 50.4a. As a protection against skeps of bees hurled down from the town walls, shields were massed above and at the side of a formation of soldiers besieging the town, to form a Roman *testudo* (tortoise). It is not clear how effective this procedure was. Cats mentioned incidents at Kissingen, now in Bavaria, and at Celle in Lower Saxony during the Thirty Years' War. Helbig's 1715 German book on the 'Catholic beehive' also referred to the use of bees at Kissingen, in 1642 or 1645. During an attack by the Swedish army under General Reichwald, the inhabitants threw all the hives they had on to soldiers trying to scale the walls, and this was said to cause such disorder that the soldiers rode away.

The difficulty in assessing the truth of accounts of the military use of bees is exemplified by the disparity between two records of the defence of Calenzana in Corsica against a German army in 1732. According to popular tradition, because the inhabitants lacked weapons they collected all the hives of bees in the vicinity and placed them on the window sills, balconies and flat roofs of their houses. The attacking soldiers found the town apparently deserted, but suddenly the hives were thrown down on them: they were severely stung, threw down their muskets and ran to the fountains in the town – where the Corsicans attacked and defeated them. But a journal kept by Colonel Lowendal in the German army did not mention bees. It described how two detachments reached the town, and as soon as they entered were 'attacked from all sides, were shot at from windows, doors and house roofs, and stones were thrown down on them'. Most of the officers' servants and horses were killed, and they had to leave the wounded in the church. Grégori (1967), who published the two accounts in full, commented that only the German soldiers who were buried in Calenzana knew which version was true.

Traité complet des abeilles, which della Rocca (1790) wrote from Syros in the Aegean, referred to a small privateer with earthenware hives of bees on board, which was chased by a much larger armed Turkish galley. As soon as the galley came alongside, some of the privateer's crew climbed up the rigging with hives and threw them down among the Turks who had boarded. In 1821 when Turks invaded Khalkidiki in Macedonia by land, the inhabitants placed hives of bees across the entrances to the two eastern peninsulas, which delayed the invading army for long enough to allow the men on these

Figure 50.4a A method of defence against skeps of bees thrown down from above, shown in an engraving (c. 1700) based on one published in 1664 (Sammlung K.A. Forster, 1975).

peninsulas to escape by sea and join their army (Nikiti, 1996); the third peninsula was protected by a sea channel.

50.5 After 1850

Mr Lincoln's Army (Catton, 1951) recorded an incident in Maryland during the American Civil War. It happened during the battle of Antietam (or Sharpsburg) on 17 September 1862, when there were more casualties than on any other day during the War: 7753 dead or missing and 18,440 wounded. The 132nd Pennsylvania Voluntary Infantry Regiment advanced under heavy fire from the Confederates, and 'some of the men went through a yard where there was a long row of bee hives: just then a round of shot from some Southern gun smashed through the length of these hives ... It took the combined efforts of General Kimball ... and the regimental officers to reorganize the regiment.'

During the 1914-18 War, various stories came from East Africa where British troops were fighting Germans in country with many traditional log hives hung in trees. The hives contained tropical African honey bees, which are generally much more readily alerted to sting than European honey bees; they can also sting *en masse*, and 'follow' a supposed attacker a kilometre or more from the hive. When British troops were marching on Tanga (now in northern Tanzania), Germans who held the area were said to snare the pathways with trip-cords fastened to hives in trees nearby; the advancing British activated the cords, and the bees were roused (Morse, 1955). The Battle of Tanga on 4 November 1914 has certainly been called 'the Battle of the Bees', and the British were badly stung. According to Farwell's 1989 book *The Great War in Africa (1914-1918)* hives in trees were battered by rifle and machine-gun fire. '*The Times* later reported that the hives were devilish devices which the Germans had deliberately incorporated into their defences, and this was widely believed for many years, but in fact the German Askaris were also forced to flee. In some parts of the battlefield the shooting ceased while both sides fled from the fury of the angry bees. This was the first but not the last time in this campaign that combatants were routed by bees.'

Farwell (pages 57, 174 and 311-312) gave accounts of further incidents, and Hoyt (1969) described others. On one occasion in 1917 when Captain Looff 's German column was near the border between German East Africa and Mozambique, local men were collecting honey from a tree with the aid of a honey-

guide bird (Section 8.3). The bees attacked the soldiers and continued stinging until nightfall; horses and mules were very badly injured. Dr B.F. Beck told Fife (1939) of another incident during the same War, when Allied soldiers with a train of pack animals carrying provisions were expected to go through a narrow pass in German territory. The Germans assembled hives there from the surrounding country and wired them to an electric battery, then piled up brushwood in the pass so that the soldiers would have to stop to clear it. At the appropriate moment the current was switched on, and there were said to be no survivors among men or animals after the alerted bees attacked them.

An American book on the war in Vietnam from 1965 to 1975 quoted Chi Nguyet, a guerilla, as saying that hives of bees were set up (beside a road) 'covered with sticky paper from which strings led to a bamboo trap we set on the road'. An enemy patrol disturbed the trap, and the men were put to flight, carrying and dragging their wounded (Mangold & Penycate, 1985). However, no known hive bee fits the description given: 'specially fierce ... more than twice as big as ordinary bees. They don't store honey.'

In Senegal, Gessain (1974) was told how the Iwol people had been made safe from attacks by their enemies, the Peul, in the early 1900s. The Iwol promulgated the belief that their ancestors had commanded the bees to attack any Peul advancing against them, and that a Peul who was stung would vomit blood and die. So a Peul always fled when he saw bees. In Nigeria, according to Ayoade (1977), the Tiv people kept some of their bees inside a special 'horn' containing poison, in the room where their sacred relics were stored. Any robber would then receive poisoned stings from which it was believed he would die, or contract leprosy. During war the Tiv took to the battleground a horn of bees fed on the poison and shook it in the direction of the enemy; it was believed that the poisoned bee stings would kill them. If the enemies were close by, the Tiv poured a sweet-smelling powder on them, so that bees carrying the poison would be attracted and sting them.

51

History of Other Products from Bees

51.1 Introduction

This Chapter is concerned with the minor products of honey-storing bees – pollen, royal jelly, venom, propolis and bee brood. They have been used by man since early times, either deliberately or inadvertently, but their commercial production hardly existed before the 1950s.

The origin and nature of each product are explained, then its traditional harvesting and use, and the history of its commercial production and trade. Further scientific details of all substances were given by Crane (1990a), and the International Trade Centre (1986) published current marketing data on pollen, royal jelly and propolis.

In the 1950s the price of honey on the world market was depressed by surplus production. Beekeepers in certain technologically advanced countries therefore sought ways of diversifying their source of income by developing techniques for harvesting some other hive products in bulk. If the substance was prepared in an acceptably pure form, and well packaged and advertised, it could be sold at a much higher price than either honey or beeswax. The term 'apitherapy' was introduced for the use of bee products to treat human disorders or to encourage health, and its practitioners had a common bond in believing that substances collected or produced by honey bees were essentially beneficial to human health. An International Association of Apitherapy was established in Canada in 1962. The materia medica of apitherapy comprised: honey; pollen and propolis, which are plant products collected by bees; beeswax, venom and royal jelly, which are honey bee secretions. Books on the subject were published, for instance in French by Caillas (1953) and *Revue française d'Apiculture* (1987), in Russian by Ioirish (1964), in German by Herold (1970) and in Italian by Bailo (1981). Conferences on apitherapy were held:

- from 1974 onwards by Apimondia (International Symposia on Apitherapy)
- from 1978 onwards by the North American Apiotherapy Society
- in 1991 in Cuba
- in 1996 in Israel

In many countries the sale of medicinal products was governed by legislation which strictly limited claims that could be made for them; this did not necessarily apply to 'natural health foods', which thus provided an alternative outlet for the products.

51.2 Pollen as a bee product

In the nest or hive, bees usually store pollen between the central brood nest and the outer honey stores, so some honey combs harvested were likely to contain pollen. Since Ancient times bee-collected pollen was referred to as bee bread, and later as farina; Section 52.91 describes the development of knowledge about it. The earliest references found to its medical uses are in books by Arab and Jewish physicians in Islamic Spain, although the pollen may not have been bee-collected. Maimonides (1135-1204), a Jew in Córdoba who was a physician to the Sultan of Egypt, recommended its use as an astringent and sedative tonic. In the early 1200s Ibn el-Beithar described it as an aphrodisiac which was also beneficial for the stomach, bowels and heart; it reduced the 'fervour' of the blood, and cured swellings produced by eating certain foods (Monferrer, 1991).

Among the few later references is one concerning Abraham Lincoln (1809-1865). As a child in Indiana he was used to eating honey from bees' nests, and a biography quoted the following from a letter written shortly after his death: 'Mr Lincoln was very fond of honey. Whenever he went to Mr Short's house he invariably asked his wife for some bread and honey. And he liked a great deal of bee bread in it' (reprinted in *Bees and Honey* 6(1), 1989).

A US Army officer, who escaped from a Japanese prison camp in China in the 1940s, described (in McCormick, 1960) the use of wind-blown tree pollen by people in the jungle. When they found him near to death, they fed him first on a certain fruit pulp mixed with pollen, and coated his much wounded feet

with a thick layer of pollen on which warm honey was spread. He reckoned that these treatments saved his life, and the use of his legs. The people stored the dry pollen in clay jars sealed with mud and used it as medicine, antiseptic and food. They also kneaded honey and pollen together into flat strips which were dried. These were eaten daily, and also served as a survival food on hunting trips and during the monsoon season. In Yucatan, Mexico, cells of pollen were collected from traditional hives of stingless bees and spread as a paste on tortillas (Weaver & Weaver, 1981).

In the diversification of hive products during the 1950s, when beekeepers learned by experience the onerous work involved in the production of royal jelly (Section 51.3), some were attracted by the easier alternative of harvesting and selling pollen.

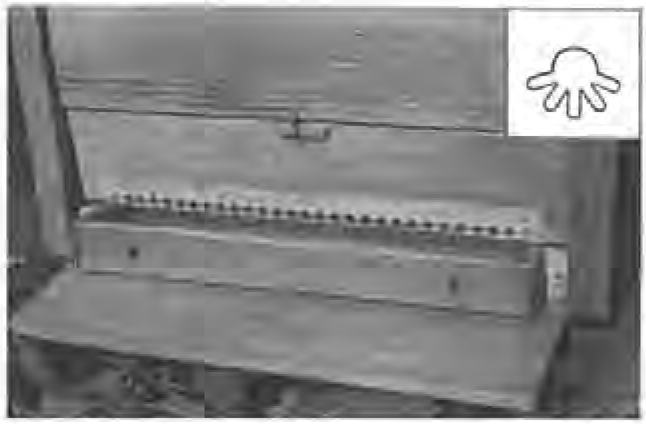


Figure 51.2b Early pollen trap, used by F.K. Böttcher in Germany, 1941 (photo: W.A. Stephen). Inset shows the shape of the holes.

Commercial production

Foraging bees pack pollen in 'loads' or pellets on their hind legs, as in Figure 51.2a. In 1941 scientists devised a way of harvesting pollen from hives to feed to other colonies when they needed it. Schaefer and Farrar in the USA, and also Böttcher in Germany, described 'pollen traps' for collecting the pollen loads from the bees' legs as they entered their hive (Figure 51.2b); a simple metal grid (5 meshes/inch, 1 per 5 mm) was used later. The trap was fixed across the flight entrance so that incoming bees had to pass through it; it knocked off some of the pollen loads, which fell through a horizontal grid with a smaller mesh, into a tray which the beekeeper emptied every few days. Subsequent traps allowed more bees to pass through at the same time; they had a larger grid, placed horizontally at the bottom of the hive, with a large collecting tray below. Pollen traps were also devised to fit at the top of the hive where no refuse could drop through them on to collected pollen. In 1948 Woodrow in the USA published drying and storage treatments for collected pollen, and in 1980 Chambers in Australia developed these further. Pollen could be produced commercially only where it was very plentiful, and in relatively dry areas; the harvested pollen is rich in nutrients, and is easily spoiled by the growth of micro-organisms if the air humidity is high.

Figure 51.2a Honey bee returning to the hive after collecting pollen from willow; she is still packing it into the loads on her hind legs (Hodges, 1952).

A colony in a modern hive may use at least 35 kg of pollen a year. A pollen trap must not remove all the incoming pollen, but the bees can compensate for the removal of say 10 kg a year by collecting more. Most pollen harvested from hives was used for feeding to bees, or as a human dietary supplement. In addition, pollen from specific cultivars was used for fruit pollination, and for plant breeding. As early as 1932, Burrel and King in the USA had described a metered 'pollen-distributing trap' (pollen dispenser) fitted across the entrance of a hive placed on or near the crop to be pollinated; it dusted outgoing bees with (hand-collected) pollen from a selected cultivar, and this ensured pollination of the crop with this pollen.

From 1980, attempts were made to use the composition of pollen collected by bees to monitor environmental pollution, including that due to radioisotopes, and also (by prospectors) to detect the presence of valuable heavy metals in the soil (Crane, 1984b).

Pollen is known to have been produced commercially in the following countries in the 1980s:

Europe: France, German Federal Republic, Hungary, Romania, Spain, USSR, Yugoslavia
Americas: Argentina, Chile, Mexico, Uruguay, USA
others: Australia, China, Israel, Taiwan, Tunisia, Vietnam.

The total world production is not known, but it must be greater than that of any other bee product except honey and beeswax. In the late 1980s Western Australia produced from 60 to 130 tonnes a year, which was sold at US$5 to 6.50 per kg. Taiwan produced 150 tonnes a year, but this may not all have been bee-collected. Dry pollen from wind-blown plants was sometimes collected in bulk, for instance in Romania when corn (maize) plants were being detasselled by machine.

51.3 Royal jelly as a bee product

During the 1700s, scientists differentiated between the brood food secreted by worker honey bees into worker cells and that secreted into queen cells (Figure 51.3a), which became known as *gelée royale* or royal jelly; Section 52.92 gives its history. Hunter-gatherers and traditional beekeepers must sometimes have eaten royal jelly inadvertently in combs they harvested. (In certain areas of the Ivory Coast, any found was taken home and given to the old people; Borneck, 1976.)

Royal jelly was probably first sold as a commercial product in France in the early 1950s; beekeepers found that they could produce royal jelly in some areas which then lacked sufficent bee forage for profitable honey production, by feeding colonies with sugar syrup and pollen. The work involved a series of labour-intensive procedures carried out to a rigorous timetable; M.V. Smith (1959) described the operations as follows. A colony was given 40-45 larvae, each grafted into a queen cell as in Section 44.22; three days later the cells contained the maximum amount of royal jelly, and this was extracted with a suction pump (Figure 51.3b). The larvae were discarded and the cells used again. The following amounts of royal jelly were harvested from well managed hives in Canada:

extraction from one cell	200-250 mg
from one hive per day	7 g
from one hive per 3-month season	0.5 kg
from 2000 hives per season	1 tonne

Figure 51.3a Section through a sealed queen cell containing a larva and (above it) a supply of royal jelly (photo: G.H. Hewison). When adult, the queen will emerge through an opening she makes at the bottom of the cell; the top of it is attached to the comb.

The royal jelly was refrigerated immediately, and could be kept for several years at –18°; freeze-drying under vacuum produced a powder which was much more stable.

Figure 51.3b Suction pump withdrawing royal jelly from rows of artificial queen cells taken from a hive, 1956 (photo: Miel Carlota, Mexico).

The larval queen's diet of royal jelly results in a 1300-times increase in body weight in 6 days; moreover a queen may live several years, whereas a worker lives only a few weeks in summer. Some people therefore believed that royal jelly would slow down the human ageing process, and increase human vigour and libido. In some countries it was promoted and sold as a dietary supplement and as a treatment for a wide variety of disorders, and for many intractable complaints with vague symptoms such as headache and fatigue.

Royal jelly production proved profitable in France by 1953, and in 1958 1.5 tonnes were produced. The price per kg was then between US$220 and 500, but by 1964 it had dropped to US$70. Table 51.3A gives some production figures in 1964 and 1984, and the amounts produced and imported during certain years in Japan, the country most notable for its consumption. By 1982, royal jelly was available there fresh, dried and processed; under Japanese law any royal jelly product – which might also contain honey, lactose, starch and other additives – had to include at least one-sixth by weight of royal jelly. In replies to a questionnaire, 80% of users claimed that it had beneficial effects (Yoshida & Matsuka, 1983). In 1986, Nakamura published quality standards for medicinal use, and also composition standards for use as food, and two companies in Japan were licensed to produce royal jelly. In 1990 a National Standard for royal jelly was operative in Vietnam.

Table 51.3A
Annual production and consumption of royal jelly in major countries concerned

Production in 1964 and 1984 (tonnes)
(Tanji Inoue & Atsuo Inoue, 1964; Crane, 1990a)

	1964	*1984*
Asia		
China	yes	400
Taiwan	0.05	234
Japan	1.5	33
Korea	0.3	?
Thailand	?	12
Vietnam	?	>1
Israel	0.05	>1
Europe		
France	1.5	>1
Italy	0.1	>1
UK	?	0.5
Czechoslovakia, Germany, USSR	yes	
Russia		9 (1993)
Americas		
Uruguay	?	>1
Canada, USA	yes	yes

Consumption in Japan, the major user (tonnes)
(Crane, 1990a)

Year	*Production*	*Imports*	*Total*
1972	9	24	33
1978	23	99	122
1982	18	140	158
1984	33	182	215
1985	46	210	256

51.4 Venom as a bee product

Figure 50.1a shows the barbed sting of a worker honey bee. When the bee stings she injects some of the venom from her venom sac, as explained in Section 50.1. The 1758 English edition of Swammerdam's book, with his drawings made around 1670, stated that the 'venomous liquor ... which passes through the sting, is originally ... contained in a little bladder, nearly transparent. The sting itself is not in the least degree venomous.'

It was often believed that bee stings have a beneficial effect in preventing or curing certain types of rheumatism and some other disorders. According to Broadman (1962), the medical use of bee venom was referred to by Hippocrates in his books on medicine (c. 430 BC), by Pliny in *Naturalis historia* and by Galen (c. AD 148). Broadman (1958) said that Charlemagne was treated with bee stings, and also gave references to recent reports on the use of stings to treat rheumatism. Since Antiquity, bees were also employed to sting unwilling victims as a punishment, or in warfare (Chapter 50).

In the late 1800s attempts were made to collect bee venom, and the first person to succeed was probably J. Langer at the University of Prague in 1897/99. His earliest method was to press the lower part of the abdomen of an individual bee, so that she protruded her sting with a drop of venom at the end; this venom was collected in a capillary tube, or washed off with saline solution, or absorbed on suitable paper or cloth. Langer needed 25,000 bees to produce 1 mg of pure crystalline venom, but the bees were not killed and could be used again. Alternatively, after applying pressure as above, the whole sting apparatus was pulled out from the bee with forceps. Extraction of the venom was then more complicated, but the yield per bee from one operation was higher, and Flury and others increased this by first killing or narcotizing the bee.

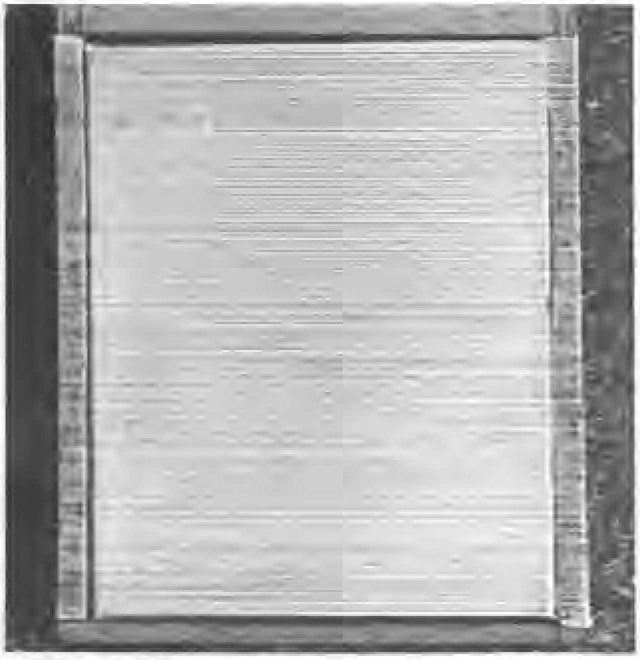


Figure 51.4a Apparatus for collecting bee venom (Morse, 1964). See text for details.

Beck (1935) gave details of various procedures used in the early 1900s.

The firm Mack at Illertissen in southern Germany started the commercial preparation of bee venom in 1930 (Forster, 1985). It owned many colonies of bees, and purchased additional bees from the Lüneburger Heide in north Germany (Section 27.21) when their useful life at the heather flow was finished. To collect the venom, girls were stationed in front of a row of hives, to pick up bees one at a time as they left the flight entrance; pressure was applied to each bee (as in Langer's early method) so that it stung into a piece of absorbent fabric. The venom was extracted with solvent and used to prepare an injectable solution whose concentration was standardized. In 1936 Mack developed a less labour-intensive method. A number of bees were put into a shallow box, 50 x 40 cm, whose base and lid were lined with absorbent filter paper protected by a thin rubber membrane. Electric wires were laid 2.5 cm apart across the base, and when the lid was closed the bees inside were in a single layer; they were given a slight electric shock from the wires and as a consequence they stung through the membrane. Venom was extracted as described above. In both these methods the bees died after stinging.

In or before 1960, a large-scale method was developed in Czechoslovakia which used a membrane so thin that a bee could retract her sting from it, and the same bees were made to sting repeatedly; see also Benton *et al.* (1963). The membrane was stretched over a square frame the width of the hive (Figure 51.4a), and bare wires were fixed across it. It was mounted horizontally just in front of the hive entrance, and a low voltage applied to the ends of the wires. Bees on the membrane received a shock and stung into it, and also released alarm pheromone which alerted many other bees to sting the membrane – and anything in the neighbourhood, so the work was not very pleasant for the operator. The venom was collected from the underside of the membrane; in hot weather the drops crystallized and could be scraped off. From 1974, Mack used a similar method, but with wires laid across a glass surface. The electric shock caused the bees to extend their stings slightly and release a drop of venom, which dried on the glass.

By using this electric-shock treatment, each bee might sting 10 times during a 15-minute collection period, producing about 0.1 mg of whole venom (0.011 mg of dried venom). After stinging 30 times a bee's venom sac would be emptied, and no more venom could be collected from the colony for 3 weeks or so, when another group of bees had developed to maturity (Galuska, 1972).

The bee venom collected was extracted with distilled water or another solvent, and freeze-dried to evaporate the solvent, leaving the venom as a crystalline powder which could be kept for a long period. Most venom was used in injectable pharmacological preparations for treating arthritic and rheumatic disorders and for desensitizing patients allergic to bee stings. Beck, one of the main practitioners, gave fairly full details in 1935. At that time commercial preparations of bee venom were produced in Austria, Germany, Switzerland and the UK. The following countries were reported to have used bee venom since 1973, but amounts are not known.

Europe: Austria, Bulgaria, Czechoslovakia, France, German Federal Republic, Italy, Poland, Romania, Spain, UK, USSR, Yugoslavia
Americas: Brazil, Canada, USA
Asia and Africa: China, Israel, Japan, Taiwan, Egypt

51.5 Propolis as a bee product

Propolis is the name given to a variety of sticky substances collected by bees; they are produced by plants as secretions and as exudates from wounds. Some of its components have a prophylactic function in the plant. Propolis contains many flavonoids, and

is more active against micro-organisms than any other substance produced or used by bees. It is collected by stingless bees and all honey bees except *Apis cerana*. (Until *A. mellifera* was introduced, peoples in northern Asia had no propolis unless they harvested it from plants, or imported it.)

Propolis is quite hard when cold, but becomes viscous when warmed. Honey bees can live without it, but if they collect it they use it to seal cracks or small holes so that the interior of their nest or hive has a smooth surface, which is less likely to shelter eggs of the wax moth. Sometimes a colony of tropical African bees nesting in a rather open rock cavity covers most of the opening with a propolis curtain. If this is extensive, large pieces of propolis can be harvested from it without difficulty (Nightingale, 1983). In South Africa, D.J.C. Fletcher found a nest which the bees had enclosed completely in a propolis envelope 85 x 60 x 45 cm. Farther north, European Caucasian honey bees collect unusually large amounts of propolis.

Propolis in Ancient times

Man used propolis from early times for different purposes: in medicine; as an adhesive and to seal cracks; dissolved in various organic solvents to protect wooden and other surfaces and to improve their finish. Referring to Ancient Egypt, Lucas (1962) went no further than to say that 'a vegetable resin or propolis intentionally mixed with wax' may have been used as an adhesive and cement; also that some specimens found in a toilet jar 'may have been propolis' – possibly used for fixing the hair. Rosalie David (1992) knew of no more recent study.

Writers in Ancient Greece and Rome were familiar with propolis, and knew that bees collected it from plants and used it in the hive (Section 52.31). The Aristotelian *Historia animalium* referred to the substance which the bees smeared at the hive entrance (*mitys*) as 'a cure for bruises and suppurating sores' (IX.40.624a).

In Rome, according to Varro, propolis was used 'by physicians in making poultices, and for this reason brings even a higher price than honey on the Via Sacra' (III.16.23). But we know nothing about the harvesting of propolis in the Ancient World.

Other regions and later periods

Propolis was applied as an adhesive by some hunter-gatherer peoples, and this continues. The Museum of Mankind in London has a musical instrument from Baka Pygmies in Cameroon, and eight pieces of equipment once owned by a Kanba medicine man in Kenya, made with the aid of propolis. Kikuyu beekeepers and some others in Kenya carried with them a chunk of propolis fixed to the end of a stick, to rub over the inside of an empty hive so that it was attractive to bees. There are similar reports from Zambia.

Medical uses of propolis continued after the Ancient civilizations. The Arab physician Avicenna (980-1037) said that it 'expels the tip of an arrow, or thorns, embedded in the skin, and cleans and softens it'. It was mentioned in Georgian medical texts from the Caucasus region written in the 1100s to 1400s (Debuyser, 1984). The Inca in South America, who were conquered by Spaniards in the 1500s, were said to treat 'inflammations accompanied by fever' with propolis (Asís, 1989).

The word propolis first appeared in an English text – by John Trevisa – in 1396 (*OED*), and in a French text – by Ambroise Paré, surgeon to Kings of France – in the 1500s (Debuyser, 1984).

In recent times it became customary to sell propolis in capsules and tablets or as granules, to be chewed or swallowed. Propolis has also been a component of certain throat pastilles and chewing gums, cosmetics and healing creams, and medicaments for treating digestive disorders. Especially in countries of eastern Europe, it was used to treat a wide variety of disorders, and there were many claims to success. A few people are allergic to propolis (see e.g. Hausen *et al.*, 1987), and some beekeepers suffer from eczema as a result of their contact with it. In 1979 Ghisalberti summarized knowledge of the composition of propolis, and discussed some historical uses of it in relation to its components then known; many further components have since been identified.

Propolis was a common component of varnishes. Such varnishes are said to have been applied to violins made in northern Italy between 1550 and 1750, and to be responsible for the special tone of violins made by Stradivarius and others in Cremona, where bees collect propolis from poplar trees. After studying the information available, Jolly (1977) concluded: 'It may well be that in the material collected by the bees in certain locations [the hard and softer components] were in just the right ratio for satisfactory drying and lasting suppleness, although it is highly questionable whether they materially affected the tone of the violin on which they were applied.'

Harvesting and trade from the 1950s

With modern hives, propolis was easier to collect than any other substance considered in this Chapter (except brood), and in the 1950s and 1960s it was explored as a bee product that could be produced in

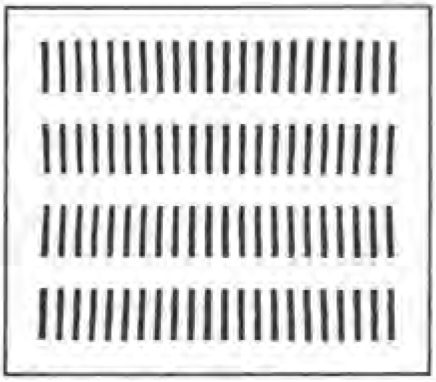


Figure 51.5a Plastic propolis collector, Hungary, 1983. Actual size 135 x 115 mm, gaps 2 mm wide.

bulk. This was done by providing artificial holes or gaps about 2 mm wide in the interior hive surface so that the bees would fill them. A board or stiff plastic sheet covered with slots was used (Figure 51.5a), or alternatively a net or gauze. It was inserted at the top or side of the hive, outside the frames; when the bees had filled the gaps with propolis, the insert was removed from the hive and placed in a deep-freeze, so that the propolis became brittle and could be fractured off by a sharp blow.

The first book on propolis (Asís, 1979) was published in Cuba, and another by Nowottnick in Austria (1987). There have been others on propolis in medicine.

Information about world trade in propolis is very incomplete. Exports from some countries in 1984 were reported:

35 tonnes: China
19 tonnes: Romania (1993)
7 to 8 tonnes: Argentina; Chile + Uruguay
3 to 4 tonnes: Canada
unknown amounts:
Europe: Austria, Bulgaria, Denmark, France, GFR, Spain, USSR
elsewhere: Australia, Brazil, New Zealand, USA.

During the 1970s, prices as high as US$160 per kg were offered for propolis, but many beekeepers inexperienced in its production supplied 'propolis' containing some beeswax, which therefore did not reach the required standard of purity. By 1980 the world price had dropped to around US$40 per kg. From 1987 Japan imported rapidly increasing amounts, 97% of it from Brazil, and Yamamoto (1996) quoted a 'US $200 million market' since 1985.

51.6 Brood as a bee product

The earliest food harvested by man from bees' nests would have been pieces of comb, and honey hunters in most parts of the world relished eating brood comb as well as honey comb. In the tropics honey was a treat — the sweetest food early man ever had — and brood was 'meat' that could sustain him for a longer period. Amounts of fat and minerals in mature larvae and pupae of honey bees (*Apis mellifera*) are about the same as in beef, and amounts of protein about 64% and 87% dry weight, respectively (calculated from Crane, 1990a). Bee brood also contains significant amounts of vitamins A and D, whereas beef has none.

Holt's *Why not eat insects?* (1885) hardly mentioned bees, but Bodenheimer's *Insects as human food* (1951) gave much information on the eating of bee brood, and pointed out that insect meat was valued in the tropics where fewer large animals provided meat than in temperate zones. Chapters in Part II, on harvesting honey from bees' nests, gave examples of the use of bee brood as food.

In 1992 I watched the harvesting of honey and brood from traditional hives of *Apis cerana* in Nepal, at Kurintar near Mugling. A hive to be harvested was lifted from its place under the eaves of the house and placed on the ground, and the extended family gathered round to watch. As each comb was removed, the part with brood was cut out and placed in one dish, and the part containing honey in another; two or three intact combs were left in the hive. The two dishes were taken to the beekeeper's wife, and each onlooker collected a piece of the brood comb from her and ate it straight away – with obvious enjoyment (Figure 51.6a). Any brood comb left was eaten later the same day. The honey combs in the other dish were squeezed, and the warm liquid honey poured into jars for later use.

Insect eating extended to the temperate parts of eastern Asia, including Japan. According to Verma (1989), peoples who ate brood – for instance in Korea, China, Japan, Thailand and Vietnam – preferred a single-box hive, since they were accustomed to harvesting the brood with the honey. On the other hand, peoples in Asia who did not eat brood – for instance in India, Pakistan and Bangladesh – willingly used tiered movable-frame hives when these became available, and harvested supered boxes containing honey only.

Jakun people in Malaysia (who also fed on durians for 6-8 weeks in the season) were gourmets among insect eaters. According to an 1865 report (Bodenheimer, 1951), comb containing mature brood, pre-

Figure 51.6a Nepali boy eating brood comb fresh from the hive 1992 (photo: H. van Blitterswijk).

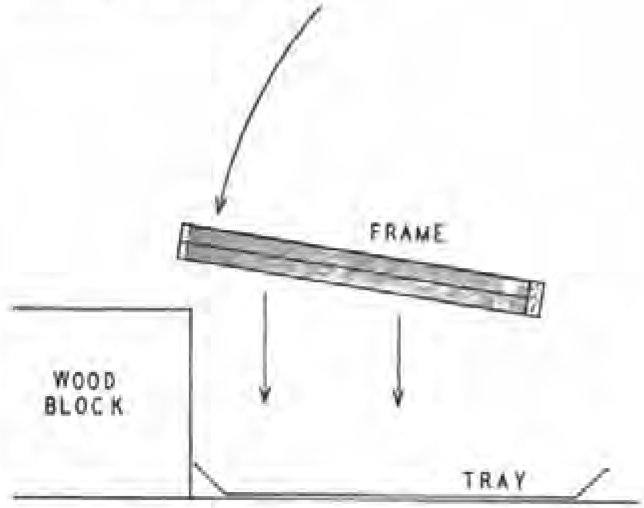


Figure 51.6b Arrangement for extracting brood from an uncapped framed comb by swing and impact (Hocking & Matsumura, 1960).

sumably of *A. cerana*, was one of their most prized foods. 'They wait until the small bees are well formed in the cells; a few days before they are ready to fly, the honey-comb is taken with great care and wrapped in a plantain leaf, and put upon the fire for a few minutes. The wax and insects are devoured together, and are considered an uncommon treat.' Brood of *A. dorsata* was also eaten in Asia, and Lao honey collectors in northern Thailand ate more of it than of any other insect; they also ate brood of *Xylocopa* and *Nomia* bees (Bodenheimer, 1951).

In Africa, according to Griaule (1928), Ethiopians ate comb containing brood and believed that this hardened the head and made it resistant to blows. In the rain forests of Zaire, the Ngandu ate larvae of honey bees and three species of stingless bees, with the honey they collected from their nests (Takeda, 1990). Stingless bee brood was eaten by other peoples, including the Tongwe in Tanzania (Kakeya, 1976), and in South America the Ache in Paraguay (Hill *et al.*, 1984).

Adult bees were less usually eaten, but Knox (1681) said of honey collectors in Sri Lanka, 'they boyl and eat, and esteem excellent food' the *A. dorsata* bees which dropped off the combs being harvested. Powdered dead bees were used in medicaments from Ancient times. Mouffet (1658) cited a reference by Pliny to ground-up bees in remedies for a wide range of disorders. Ashes from burned dead bees were an ingredient in some classical remedies (Beck, 1938) and in others used by Celtic peoples (Williams, 1972).

One of the few attempts to develop brood harvesting from movable-frame hives was in western Canada, where colonies from package bees were routinely killed at the end of summer (Section 44.32). Figure 51.6b shows how brood was extracted from the combs after uncapping them. Hocking and Matsumura (1960) tried to find an economic use for the 130 tonnes of brood they reckoned were wasted annually, and experimented with different ways of preparing the brood for human consumption. They found that frying and baking were the most acceptable.

Prohibitions on eating bees

Some religions which originated in the eastern Mediterranean region forbad the eating of certain insects. Laws attributed to Moses in about 1200 BC (Leviticus 11.21) allowed insects such as locusts to be eaten, whereas others – which would include bees – were proscribed as being unclean, and this was still true when the *Talmud* was written (Section 54.34). A sentence in a Dead Sea scroll, written about 200-100 BC, had also forbidden eating bee brood: 'Let no man defile his soul with any living being or creeping thing by eating of them, from the larvae of bees [in honey] to all the living things that creep in water' (Allegro, 1956). In the 1990s Muslims explained to me that they did not eat the digestive system of an animal (it

was unclean), and it would not be possible to remove this from a bee, so bees were not to be eaten. Religious prohibitions on eating honey, because bees from which it came were considered unclean, are mentioned near the end of Section 54.34.

Adherents of some other religions – Buddhists and Jains – were forbidden to eat bees for quite a different reason: that it was wrong to kill any animal. In Nepal (1990) I was told that a Brahmin (the highest Hindu caste) might keep bees, but would not eat brood.

Europeans living in temperate climates, where Christianity spread early, had no need to eat insects, and brood for human consumption was rarely listed among bee products in the Western World. Bodenheimer (1951) concluded that: 'the aversion to insect food in Western civilization, though an established fact, is nevertheless not based on hereditary instinct. It is established by custom and prejudice.' He was not concerned with religious prohibitions, but suggested other reasons. For instance in the temperate zone there were no insects as large as some in the tropics. Also, animal rearing and crop growing developed earlier; people had an adequate diet without having to hunt such tiny game as insects. As a result, Europeans came to despise insects as food.

Part X

BEES IN THE HUMAN MIND

Chapters 52-54

52

The Growth of Knowledge about Honey Bees and their Products

52.1 Basis of knowledge about the bees

52.11 The general picture

From early times, honey bees were the insects most widely useful to man, because they produced honey and wax. The life of the bees in their social community aroused great wonder and interest, but people who harvested honey combs from natural nests learned rather little about this. When bees were kept in hives there were frequent opportunities to watch them flying, and if a beekeeper took all the combs from a hive at harvest time after smoking the bees away, he would have been able to see brood.

Some facts about bees were known in Ancient Egypt, and in other early civilizations in the Mediterranean region and lands immediately to the east, and later in Europe to the north. Aristotle's books were the basis of knowledge about bees throughout the Middle Ages and until the scientific revolution which started in Europe during the 1500s and 1600s. In many Sections of this Chapter there is a time-gap between writings by Ancient authors and publications after about 1600 which described observations and discoveries, and thus advanced knowledge in a scientific way.

Specialization in the sciences hardly started before the 1900s, and until then most interested individuals studied a wide range of subjects. Much of the growth of knowledge about honey bees was haphazard, and often our only clues to its progress through the centuries are a series of isolated statements – some indicating important discoveries – by individuals who had no contact with each other. We know that certain findings about bees were made several times independently. Frequently, when a new investigative technique was developed – for instance use of the microscope – or an advance was made in wider scientific fields, some characteristic of honey bees was observed and understood for the first time. Nevertheless many questions that puzzled beekeepers since early times were not answered until the late 1900s.

One of the astonishing features of beekeeping is that for most of its existence (up to nearly AD 1600) it was successfully carried out in many parts of the world by beekeepers who did not understand the origin of bees, their method of reproduction, or the sex and functions of the large 'ruler' bee.

Stingless bees (Meliponinae) and Asian species of honey bees were not studied in detail until the 1900s, and development of knowledge about them followed a more logical pattern. Asian species of *Apis* are mentioned in several parts of this Chapter, and Appendix 1 gives some idea of early knowledge about these bees in China. Section 29.41 refers to knowledge in Vietnam in the 700s and later.

Bibliographical sources

Table 52.1A lists books about bees and beekeeping written before 1459, when the first books were printed in Europe. Printed books on bees and beekeeping are well documented: in 1881 Keller in Italy published a bibliography of several thousand; in the 1900s bibliographies were compiled by region or by language.

Sweden (Hebbe, 1939)
German language (Droege, 1962/68)
French language (Casteljau, 1983)
Britain and Ireland (IBRA, 1979)
Canada and USA (Johansson & Johansson, 1972a)
New Zealand (Reid *et al.*, 1988)
tropics (Crane, 1978a).

In Asia, Osborn (1952) summarized early entomological work on bees in general, and Maa (1953) that on the systematics of the honey bees. *Bibliographical tools for apiculture* (Crane, 1984a) leads to many other bibliographies and catalogues of specialist libraries.

Le Sage (1974, 1975) discussed the origins of words in different Indo-European languages for bee, drone, queen, swarm, comb, hive, honey, beeswax and mead.

Table 52.1A

Chronology of manuscript writings on bees and beekeeping before the first printed books in Europe (1459)

Period is the known or supposed life period; brackets indicate the supposed period of activity. Titles mainly on bees or beekeeping are marked *. Early printed books are referred to under country at the end of Sections on traditional hive beekeeping.

Period	*Author*	*Title*	*Language*	*Reference*
Carthage				
between −250 and −150	Mago	books lost	Phoenician	Mahaffy (1875)
Greece				
−384/−322	Aristotle	*Historia animalium* (except Book IX) *De generatione animalium*	Gr	
−372/−288	Theophrastus	many books mention bees	Gr	F1951a
(−300/−30)	Philiscus	*?*Melissourgika* – book lost	Gr	
(−300/−30)	Aristomachus	**Melissourgika* – book lost	Gr	
c.−135	Nicander	**Melissourgika* – book lost	Gr	F1951a
−70	Mago (1st entry)	translated by Cassius Dionysus – book lost	Gr	
Rome				
−234/−149	Cato	*De agri cultura*	La	F1951a
after −146	Mago (1st entry)	translated by order of Roman Senate – book lost	La	
−116/−27	Varro	*Res rusticae*	La	F1951a
−70/−19	Virgil	*Georgica* (*Georgics*)	La	F1951a
−64/+17	Gaius Julius Hyginus	*De agricultura* – book lost	La	F1951a
−63/+10	Didymus	*Geographica*	La	F1951a
(*c.*30)	Celsus	*De medicina*	La	
(*c.*60)	Columella	*De re rustica*, **Liber IX*	La	F1951a
23/79	Pliny the Elder	*Naturalis historia*, **Liber XI*	La	F1951a
(died *c.*222)	Aelian	*De natura animalium*	Gr	F1951a
(300s)	Palladius	*Opus agriculturae*	La	F1951a
Europe and Middle East				
333-397	Ambrose	*Hexameron*	La	A1940b
560-636	Isidore of Seville	*Originum sive etimologiarum*	La	A1940b
(*c.*950)	order of Emperor Constantine VII	*Geoponica*	Gr	F1951a
980-1037	Avicenna or Ibn Sina	*Tractatus*	Ar	Monferrer (1991)
1098-1178	Abbess Hildegarde of Bingen	*Physica*	La	A1942
(1100s)	Ibn-al-Awam	(Book of agriculture)	Ar	Clement-Mullet (1864); Bee World (1932)
1126-1198	Averroës or Ibn Ruoshd	(Commentaries on Aristotle)	Ar	Jaime Gómez (1958/59)
1160-1233	Ibn-al-Athir	?	Ar	Ransome (1937)
1157-1217	Alexander Neckham (England)	*De naturis rerum*	La	A1942, F1958
1200-1280	Albertus Magnus (Germany)	*Summa de creaturis*	La	A1942
1201-1263	Thomas de Cantimpré or Thomas Cantipratensis	*De natura rerum*, including *Liber apum seu universale bonum* (printed 1472)	La	A1942
1220-1294	Brunetto Latini	*Li livres dou trésor*	Fr	A1942
(*c.*1225)	Arnoldus (Saxony)	*De finibus rerum naturalium*	La	A1942
(*c.*1250)	Bartholemaeus Anglicus	*De proprietatibus rerum*	La	A1942, IBRA (1979)
(*c.*1250)	unknown (England)	*Ceo est hosebonderie*	Anglo-Norman	Lamond (1890)
1233-1321	Petrus de Crescentiis (Italy)	*Opus ruralium commodorum*, **Libri IX, XII*	La	Martini (1968)
*c.*1235–*c.*1291	Jacob von Maerlant	*Naturen bloeme*	Flemish	A1942
*c.*1290-1349	Richard Rolle of Hampole	(Various manuscripts)	La	A1942, IBRA (1979)
1309-1374	Konrad von Megenberg	*Buch der Natur*	German	A1942

Other writers quoted in this book					
Ancient Greece				*Ancient Rome*	
−850/−800	Homer	−484/−406	Euripides	−65/−8	Horace
(−700s)	Hesiod	(born −470)	Democritus	−43/+17	Ovid
−640/−559	Solon	−448/−388	Aristophanes	(c. +100)	Pliny the Younger
−556/−468	Simonides	−427/−347	Plato	(+100s/+400s)	Pseudo-Quintilian
(−530)	Pythagoras	(−395)	Antimachus		
−490/−429	Pericles	(−325/−300)	Pytheas		
−485/−425	Herodotus	−60/+21	Strabo		

Languages: Ar = Arabic; Gr = Greek; La = Latin.
References: A = Armbruster; F = Fraser.

52.12 Knowledge in the Ancient World

The *Veda*, sacred Sanskrit books of Aryan people who moved into the Indus and Ganges valleys around 1750 BC (Section 54.33), contain passages which have sometimes been interpreted as indicating quite advanced knowledge about bees. But the *Veda* contain many forms and words that do not occur in later writings and whose meanings are open to wide conjecture. The earliest is the *Rig-Veda*, which consists of hymns collected in oral form probably between 1500 and 1000 BC and addressed to deities, the Asvins. In a long series of articles, Dave (1954/55) interpreted the Asvins as 'presiding over two kinds of Indian bees, their honey, and the art of bee culture as practised by the Vedic Aryans'. He construed some passages as referring to hexagonal cells, the arrangement of combs, the single 'king-bee', royal jelly, and beekeepers' operations including the use of smoke and requeening, presumably with *Apis cerana*. A paper by C.G. Joshi *et al.* (1983) which summarized Dave's conclusions has been cited as endorsing their validity. However, the *Rig-Veda* was much earlier than any other known descriptive writings on bees, and I found it difficult to believe that ancient Vedic Aryans had the knowledge and expertise Dave attributed to them. Dr K.K. Kshirsagar in Pune kindly consulted Sanskrit scholars, Professor P. Joshi, Dr T.N. Dharmadhikari and Dr H.G. Ranade; their conclusion was that Dave regarded mysticism as the key factor in Vedic literature, but that in this context any meaning can be deduced, and his interpretation is only one among a number that have been proposed.

There is verisimilitude in a passage in a later *Veda*: 'All the bees go up when the King-bee goes up and ... they settle down when the King-bee settles down' (*Prashnopanishad* 2.4).

The level of beekeeping apparent in Ancient Egypt from about 2400 BC (Section 20.31) suggests that its beekeepers had as wide a knowledge as that recorded by Greek and Roman writers more than 2000 years later. It also seems likely that Egyptian beekeepers knew by 400-300 BC or earlier that young virgin queens piped or 'called' in their colony, and used this fact in their beekeeping (end of Sections 20.5, 20.6). Between 250 and 150 BC Mago in Carthage wrote about beekeeping in his highly regarded book on agriculture (Table 52.1A, Section 21.5), but his text has not survived and we do not know the extent of his knowledge about the bees themselves.

The earliest surviving accounts of honey bees and their activities were written in Ancient Greece during the 300s BC, especially by Aristotle in *Historia animalium* Books I-VIII (Section 23.12). Sections below quote many of their statements, and Section 52.10 cites recent studies on these texts and also refers to some of the misconceptions about bees in *Historia animalium*.

52.2 Anatomy

A worker honey bee was used as a hieroglyph in the topographical symbol of Ancient Egypt; it was always shown in profile, as were many individual people and animals. Figure 6.3c shows examples from the first two dynasties (c. 3100-2686 BC). During the Old Kingdom (c. 2686-2181 BC) the bee was drawn in more detail, and by about 2400 in the Fifth Dynasty – when hives were also portrayed (Figure 20.3a) – the head, thorax and banded abdomen were demarcated, and the proboscis was shown as well as the two antennae. In Minoan Crete some bees were also shown in profile, as in Figure 22.2a. But on Greek coins, all representations (e.g. Kraay, 1966; Nivaille, 1978/79) show a dorsal view.

The first appreciable step forward in anatomical studies followed Galileo's construction of a compound microscope in Italy, which he described in 1610. Galileo was a member of a small but active scientific society in Rome, the Accademia dei Lincei – Academy of the Lynxes, i.e. those with piercing eyes to seek out new things – where the term *microscope* was invented in 1624 (Carutti, 1883). In the same year

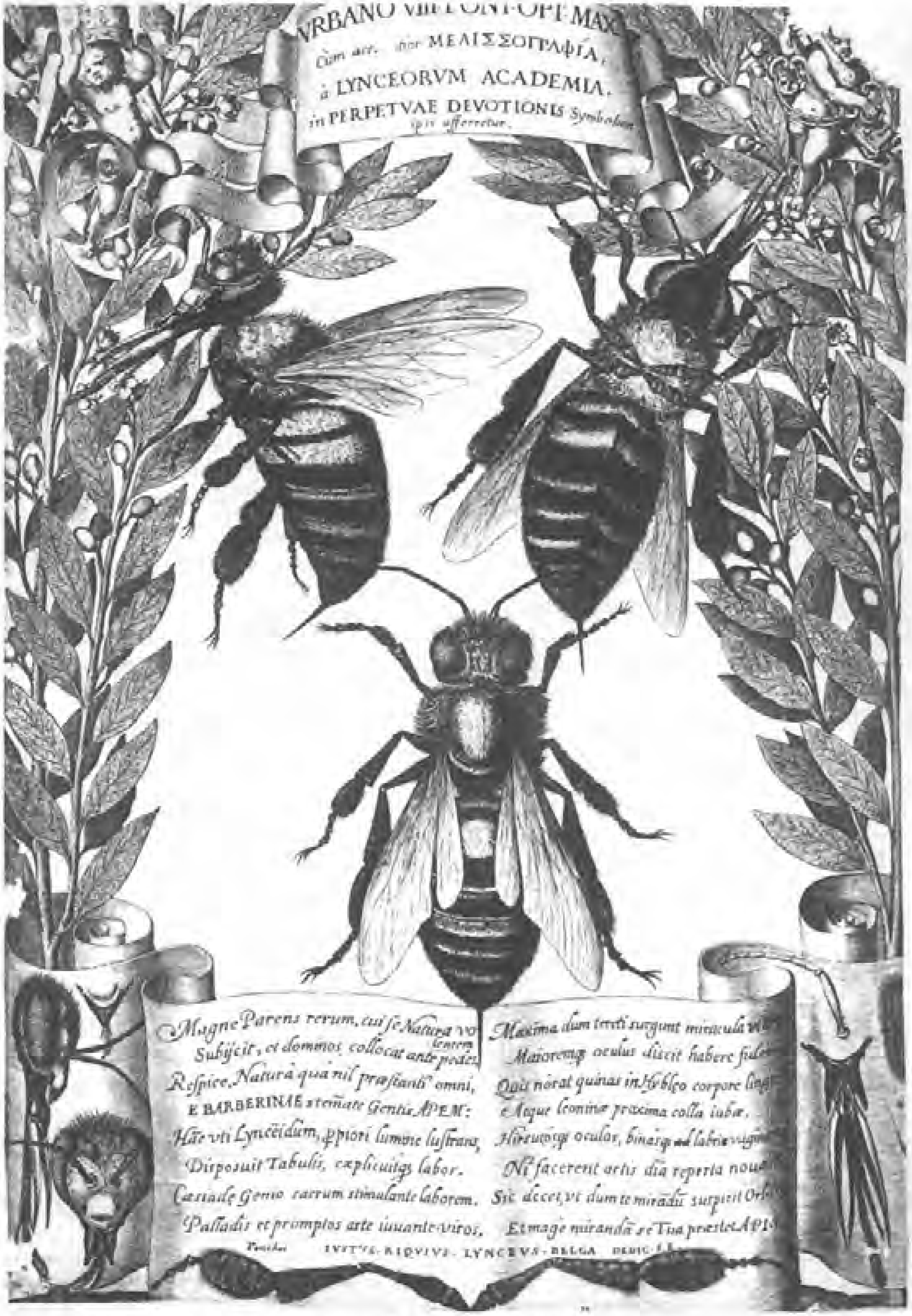


Figure 52.2a Broadsheet (100 x 64 cm) presented to Pope Urban VIII in 1625. The first drawings of bees made with the aid of a microscope; see text.

Galileo gave a microscope to Prince Federigo Cesi who had founded the Academy. At this time the scientists were in trouble with the Roman Catholic Church, and the microscope was used to draw the structural details of the three heraldic bees of the Barberini family – because Maffeo Barberini was then Pope Urban VIII. Francesco Stelluti 'accurately delineated' the bees in dorsal, ventral and lateral views, and included enlarged drawings of the bee's compound eye, tongue and sting. The drawings were engraved by Matteo Greuther, and the finished broadsheet (Figure 52.2a) was presented to the Pope at Christmas 'as a token of everlasting devotion', but it failed to assuage the Church. Crane (1963) gave more details.

Cesi started to edit the material in the broadsheet to make a textbook on bees, *Apiarium*. He cut up the text and pasted each item on a separate sheet of a notebook, and wrote notes and additions in the margins. The book was to be indexed and made suitable for quick reference (Alessandrini, 1956). In 1958 I saw the pasted-up draft in the Library of the Accademia dei Lincei in Rome.[3] But the story ended sadly: Cesi died prematurely in 1630, and his *Apiarium* was never published. Stelluti rearranged part of the material and added a description of the bee's external anatomy, and published it in 1630 in an edition of the satires of Perseus (see Figure 52.2b). Such a subterfuge was necessary because of the danger of publishing new scientific knowledge in Italy at that time.

The next advances were also made with the aid of a microscope. Both Hooke (1665) and Leeuwenhoek (1673) published a description and drawing of the honey bee's sting, and Hooke and Swammerdam studied the bee's compound eye. Some of the drawings in Hooke's *Micrographia* were made by Christopher Wren. In 1669 Jan Swammerdam in the Netherlands finished his book on anatomy, *Biblia naturae*, which dealt with many organisms although not bees. During the years 1669-1673 he studied the anatomy of the honey bee, and his drawings 'compare favourably in their accuracy and artistry with those made in our own time' (Dade, 1972). Swammerdam suffered from dropsy and died in 1680 when only 43 years old; Dodd (1980) gave details of his personal life. His work on bees was first published (in Dutch and Latin) as a section entitled *Commentarium de apibus* of the 1737/38 edition of *Biblia naturae*. The original bee drawings are in the University of Leiden; photographs of them are in the IBRA Library, and parts of two are shown in Figures 52.3a and 52.6a.

Figure 52.2b The bees in Figure 52.2a redrawn with additions, and published in 1630 with anatomical descriptions; see text.

The Italian physiologist Malpighi (1623-1694) is commemorated by the term Malpighian tubules for the principal organ of excretion in the honey bee, and the name *Malpighamoeba mellificae* for the protozoan which parasitizes them. His drawings are in the University of Bologna.

In more recent times Snodgrass's 1910 book became the standard work on honey bee anatomy.

52.3 Activities of individual bees outside the colony

52.31 Flying and foraging

The flight of bees must have been observed by the earliest peoples who encountered them. Solon's laws in Greece (594/593 BC) prohibited the siting of hives

[3] Near to it was the Secretary's handwritten report of Galileo's examination before the Inquisition: one after another, the Lynxes testified in favour of their fellow-member, but the Establishment was not won over. On 22 June 1633 Galileo was sentenced to incarceration at the pleasure of the tribunal, being 'vehemently suspected of heresy'.

within 100 m of others already in place.* In Portugal, possibly as early as the 1300s, the foraging area of an apiary was reckoned as 1500 ha, equivalent to a circle of radius 2.2 km (Section 25.32), and this is a fairly realistic assessment.

It was known in the 300s BC that bees 'discharge their excrement' in flight (*Historia animalium* IX.40.627a), and that when drones fly out 'they soar up in the air in a stream, whirling round and round' (IX.40.624a). The same passage stated that the ruler bee flew out only with a swarm; and in Rome Pliny stated that the swarm would not fly without the ruler, for instance 'if anybody should cut off one of his wings' (XI.17.54). It was known that bees foraged but was believed, wrongly, that they collected both their brood and wax from flowers (Section 52.10). It seems not to have been generally understood that they collected pollen, although Book IX of *Historia animalium* said that bees carry bee-bread (pollen) 'as they do the wax, on their legs' (40.623b). The same Book also stated that different individual (worker) bees carry out different activities, both within the colony (Section 52.41) and outside: 'Separate detachments of bees are told off for diverse operations; that is, some carry flower-produce, others carry water' (40.625b). Also: 'On each expedition the bee does not fly from a flower of one kind to a flower of another, but flies from one violet, say, to another violet, and never meddles with another flower until it has got back to the hive' (40.624b). However, the result of this – that the bee pollinates flowers it forages on – was not understood until 1750 (Section 45.3). In 1810 Feburier in France stated that bees collect nectar from flowers, with their long and supple tongue: '*s'y plonger et laper la liqueur sucrée ...*'.

The Roman writer Columella was interested in the collection of water by bees (Section 7.5), and when he was in an unfamiliar area he assessed the population of wild colonies – and thus the potential for honey production – by noting the number of bees he saw at a water source. The end of Section 52.43 mentions bees' collection of water when brood is being reared.

Historia animalium Book IX refers to bees collecting propolis: 'the "tears" or exuding sap of trees, such as willows and elms and such others as are particularly given to the exudation of gum ... With this material they besmear the groundwork, to provide against attacks of other creatures; the beekeepers call this stuff "stop-wax". They also with the same material narrow by side-building the entrances to the hive if they are too wide' (40.623b). Pliny referred to sources of propolis: 'Bee-glue from the droppings of the gum-producing trees – the sap, glue and resin of the willow, elm and reed' (XI.5.14). 'Propolis is obtained from the milder gum of vines and poplars' (XI.6.16). Much later, Réaumur (1740) described the collection of propolis by bees, and Huber (1792) managed to get them to collect it where it was possible to watch them.

> In July, some branches of the wild poplar ... with very large buds full of a reddish, viscous, odoriferous matter, were brought to me, and I planted them in vessels before hives in the way of bees going out to forage. ... Within a quarter of an hour they were visited by a bee which ... drew out threads of the viscous substance, and lodged a pellet of it in one of the baskets of its limbs. From another bud it collected another pellet for the opposite limb, and departed to the hive.

*If the law was intended to prevent competition for forage, it greatly underestimated the distance bees flew from their hives.

52.32 Stinging

The author of Book IX of *Historia animalium* knew that the worker bee had a sting, that 'young bees do not sting as the others do' (40.626b), that bees die after stinging (40.626a), that the drone has no sting (40.624b) and the 'ruler' has a shorter one – which some writers believed was never used. It was noticed that bees did not sting when away from the hive, but in its proximity 'they kill whatever they get hold of' (40.626a). Ancient writers discussed effects of being stung, and suggested remedies for the pain and swelling (Section 33.8). Swammerdam's drawings of the worker's sting, and the queen's sting and venom sac, are shown in Figures 52.3a and 52.6a, respectively.

52.4 Activities within the colony

52.41 The many different activities

Book IX of *Historia animalium* described the bees' activities within the hive as follows:

> Some make wax, some make honey, some make bee-bread, some shape and mould combs, some bring water to the cells and mingle it with the honey (40.627a). Others smooth and arrange combs (40.625b).

This concept was elaborated by other classical authors, and also by a number of European writers during the 1500s: François de Rohan in *Fleur de vertu* (1530); John Lyly in *Euphues and his England*

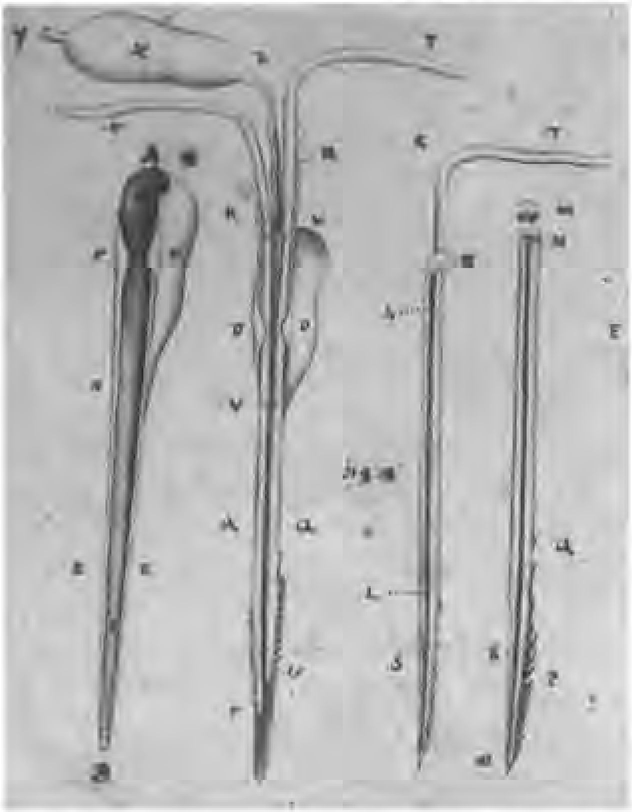


Figure 52.3a Sting of the worker honey bee, drawn by J. Swammerdam in 1669/73 and published in his Plate 18 (1737/38). The most complete drawing of the sting apparatus, with the venom sac, is second from the left. Figure 50.1a shows a recent photograph of a worker honey bee sting.

(1580); Michel de Montaigne in his *Essais* from 1533; and Shakespeare in *King Henry V* (I.2) in 1599. The 1530 and 1599 passages are quoted in Section 54.6.

52.42 Wax production and comb building

Wax production

It was stated erroneously that the 'mode of gathering wax has been observed on olive trees' (*Historia animalium* IX.40,624b). In fact, during spring in Greece bees collect pollen from olive flowers which is nearly white, and it was probably mistaken for the nearly white wax of combs built at that season (Papadopoulo, 1980).

No other origin of beeswax seems to have been put forward for many centuries. In England, Butler (1609) made a clear distinction between wax and pollen, but still believed that the bees collected the little scales of wax he saw in the hive: 'The matter thereof they gather from flowers with their Fangs: which, being kept soft with the heat of their little bodies, ... is wrought into Combs.' Martin John (1684) in Silesia reported seeing wax scales in six or more 'pockets' on the underside of the worker abdomen, but he did not know how they originated and thought that the bees found honey and wax together, outside the hive. Walker (1909) quoted the relevant passages. Réaumur (1740) believed that beeswax was produced from pollen by a digestive or fermentative action. Hornbostel in Germany (1744) thought that the wax particles were in the honey that bees collected from flowers, and were separated by digestion in the bee's body to pass through ducts under the abdomen, gradually forming cakes: 'These cakes of wax must of necessity come from the body of the bee, and be laid down in the compartments.' (Duchet in Switzerland (1771) republished the substance of Hornbostel's article as if it were an original discovery.) In England in 1744 John Thorley noted wax scales in 'pockets' under the abdomen. Then the Scottish surgeon John Hunter (1792) made wide-ranging observations on bees in a glass hive, and observed them producing wax. He concluded that 'the wax is formed by the bees themselves; it may be called an external secretion of oil'.

Finally, in 1793 François Huber (from Mlle Jurine's observations) found plates of a substance apparently analagous to wax under the bees' abdominal rings (Huber, 1814), and showed beyond doubt that beeswax was secreted by the bees provided they had access to honey or some other sugar-containing food; they did not need pollen to produce wax. The various findings were described by Walker (1909), and Casteel (1912) made the first detailed study of a honey bee's manipulation of the wax scales she produces. Hepburn (1986) gave further information.

Columella wrote that all the combs 'hang down from the roofs of the hives, adhering very little to the sides and in such a way as not to touch the bottom, thus leaving a passage for the swarms' (IX.15.7-8). 'The cells have six angles' (III.16.5).

Historia animalium Book IX stated that the bees 'first build cells for themselves; then for the so-called kings and the drones' (40.623b). Also, the best time to get combs built is during a good honey flow: 'When the floral world is in full bloom, then they make wax; consequently you must then take the wax out of the hive, for they go to work on new wax at once' (40.627a).

The structure of bees' comb and the shape of the cells in it have evoked wonder and curiosity since early times, and Betts (1921) published details about early suppositions. In the 100s BC the mathematician Zenodorus of Sicily proved that, for a given circum-

ference, a regular hexagon has a greater area than a square or an equilateral triangle, the only other figures which can completely fill a plane surface. Around AD 500 Pappus quoted Zenodurus' deduction, and commented that bees wisely chose to build hexagonal cells because these would hold more honey for the same amount of wax than either of the other possible shapes.

The Italian astronomer Maraldi was one who studied the geometry of comb in later centuries. His 1712 book – which referred to Swammerdam's drawings as 'having been promised some years ago' – included drawings of comb that are very similar to some made about 1670 by Swammerdam, but not published until 1737/38 (Plate 23). The bees' construction of combs was observed and described by Huber (1792) and Darwin (1859), and more recently by Hepburn (1986).

52.43 Brood rearing and production of brood food

It was understood in Ancient Greece that immature bees (brood) were reared and fed in the hive. Aristotle said in one passage: 'The ordinary bee is generated [reared] in the cells of the comb, but the ruler-bee in cells down below, attached to the comb, suspended from it, apart from the rest, six or seven in number, and growing in a way quite different ...' (V.21.553b). In Rome Columella referred to 'the wax which holds the seeds [worker eggs]', and also to something like 'the nipple of a breast, projecting somewhat [a queen cell]' (IX.11.4). The author of Book IX of *Historia animalium* said that drone cells 'are less in bulk than the bees' cells [occupy a smaller total area]' (40.624a), and 'are larger than the others'. However, it was not understood that the bees originated in the hive, from eggs laid by the queen, and Section 52.61 explains how this fact was later established. Aristotle said: 'Some affirm that bees ... fetch their young from the flower of [various plants]' (Section 52.10), and in Rome Virgil repeated this belief in the Fourth of his *Georgics* (200): 'The bees ... of themselves gather their children in their mouths from leaves and sweet herbs.'

Historia animalium Book IX stated: 'Bees brood over the combs and so mature them', and Roman writers gave a fuller description of the behaviour of bees rearing brood. For instance Pliny wrote: bees 'incubate in the way that hens do. ... They give the brood drops of food. ... The offspring hatched at first looks like a white maggot lying crosswise', then it begins to take shape, and finally the young bees 'break the membranes ... like egg shells' and emerge (XI.16.48-49).

In China, a passage written between AD 1000 and 1100 mentioned eggs laid by the 'king' (Appendix 1).

Historia animalium Book IX said: 'In hives that are in good condition, the production of young bees is discontinued only for the forty days that follow the winter solstice' (40.625b); this broodless period is longer in northern Europe. Further, 'A bee carries water when it is rearing grubs' (40.625b), and Columella (IX.5.5) also stated that bees need water when rearing brood.

52.44 Production of honey from nectar or honeydew

In the Ancient World it was erroneously believed that honey was collected from flowers ready made, 'deposited out of the atmosphere' (Section 52.10). Nevertheless Seneca (5 BC to AD 65), in *Epistolae ad Lucilium*, cited a perceptive suggestion about the production of honey by bees.

> They say that we should imitate the bees, who wander about and browse on the flowers which are suitable for making honey, then they arrange and distribute among the combs what they have brought in ... it is not clear whether they carry from the flowers juice which forthwith becomes honey, or change it into this sweet by some intermingling and property of their breath. ... Some think that what they have gathered from the tenderest of green and flowering plants is turned to this substance by a process of preserving and storing and by the aid, so to speak, of a certain ferment, through which different parts unite in one. (LXXXIV.3.4)

Varro (III.16.32) knew that honey was ready for harvesting 'if the bees make a humming noise inside, if they flutter [their wings] when going in and out [they fan to produce an air current which evaporates water from the honey], and if, when you remove the covers of the hives, the openings of the combs are seen to be covered with a membrane [the cells are capped], the combs being filled with honey'.

The belief that honey harvested from the hive was unchanged from what the bees collected from flowers (which itself fell from heaven, Section 52.91) lasted until about 1800, and was repeated for instance by John Hill in England (1759), John Hunter (1792) and Bonner (1795) in Scotland, and Huber (1814) in Switzerland. There were a few opponents to the common view. About 1670 (published 1737/38) Swammerdam expressed the opinion that the bees transformed the

liquid they collected from flowers 'into a better united and thicker liquid by digestion in the stomach [honey sac] of the Bee'. He thought that glandules he observed on the bee's mouthparts might play some part in this transformation. Swammerdam's book was studied closely by Réaumur in France, who (1740, p. 722) fed sugar syrup to his bees and found that what they stored in the cells tasted like true honey, so he concluded that the honey had been elaborated in the bees' bodies, but acknowledged that the syrup might have become mixed with a little honey from the countryside.

A proper understanding of the bees' production of honey had to wait until the existence and nature of enzymes were discovered in the 1800s, in the course of studies on fermentation processes. These showed that fermentation resulted from the action of specific substances which were called ferments by Louis Pasteur in France in the 1860s, but after 1877 were known as enzymes from Greek 'in yeasts'. Names of many enzymes were composed by adding -ase to a word-root indicating either the substance the enzyme breaks down or the reaction which occurs. Sucrase (invertase) converts sucrose, a main sugar in many nectars, into glucose and fructose, and in honey these are together more soluble in water than sucrose. Dufour (1899) showed that bees in the hive evaporate much water from the nectar brought in, and Park (1924, 1925) described how they manipulate the liquid with their mouthparts to enlarge its surface area. Kratky (1931) showed that invertase is produced by hypopharyngeal glands in the head of the worker honey bee; it enters the nectar during this manipulation.

In the early 1900s there were many reports of antibacterial effects of honey, and in 1937 Dold *et al.* introduced the name 'inhibines' for the agents responsible. Much was published on these inhibines, especially in Europe, until White *et al.* (1962) in the USA showed that effects of 'inhibine' were due to the antimicrobial action of hydrogen peroxide produced in diluted honey by glucose oxidase (Section 47.1). In the 1960s/70s, Maurizio in Switzerland and Burgett in USA studied other honey-storing insects (*Apis* species besides *mellifera*, and certain stingless bees, bumble bees, honey-storing wasps and honey ants). All produced both invertase and glucose oxidase, except that the wasps were not studied for invertase. Burgett (1990) and Crane (1990a) gave details of the results, which indicated an important link between different honey-storing insects: in the partly formed honey in the colony, glucose oxidase produces hydrogen peroxide which helps to preserve the liquid from spoilage.

52.45 Other activities

Book IX of *Historia animalium* referred to several further specific activities inside the hive:

- Bees use propolis to 'narrow the entrances to the hive if they are too wide', and to coat its interior (40.623b).
- 'Bees that die are removed from the hive' (40.626a).
- The bees 'kill them [the young queens] especially when the hive is deficient in grubs, and a swarm is not intended to take place. ... They destroy also the combs of the drones if a failure in the honey supply be threatening' (40.625a). 'When honey runs short they expel the drones' (40.626b). '[Nevertheless] it is a good thing to have a few drones in a hive, as their presence increases the industry of the workers' (40.627b).

Book IX also said that the bees consume honey in the winter, and that they die if not enough honey is left for them and the weather is rough (40.626b). And 'they suffer most from hunger when they recommence work after winter' (40.627a). Bees generally eat honey sparingly, but after being smoked they 'devour the honey most ravenously' (40.623b). Varro recognized that a colony of bees could 'lose heart' in a hive too large for it (III.16.15).

52.5 Communication between members of the colony

52.51 Communication by sound

Most vertebrates use sound for communication, and to the Ancients this was perhaps the most obvious method of communication between bees, especially as bees make various sounds. *Historia animalium* Book IX (40.627a) said: 'Bees seem to take a pleasure in listening to a rattling noise. ... It is uncertain, however, whether or not they can hear the noise at all.' Pliny (XI.22.68) asserted that 'bees delight in the clash and clang of bronze', referring to the belief that a swarm in flight would descend and settle in response to a person 'tanging' – making a loud noise by beating a resonant metal vessel, as in Figure 52.5a. Figures 26.2g, 32.3b, 33.4a, 33.4c, 52.10a and 53.3a also show tanging in western Europe during the 1400s-1600s. Herrod-Hempsall (1930) cited examples up to the 1900s of the belief in its effectiveness. A few writers thought that tanging was useless, including Butler (1609) and Thorley (1744) in England.

Figure 52.5a Tanging a swarm as envisaged by Wenceslaus Hollar in an engraving in the Fourth of Virgil's *Georgics* translated by John Dryden (1697). Tanging is explained in the text. Skeps were used in northern Europe, but not in Rome.

In more recent studies scientists found no receptors for airborne sounds in honey bees, and generally agreed that the bees could not hear these. Tanging was, however, useful because a swarm was regarded as the property of the owner of the hive it came from, so long as he kept it in sight, and tanging made public his active pursuit of his swarm. However, research in the late 1900s (outlined by Dreller and Kirchner, 1995; also Towne, 1995) showed that in some circumstances *A. mellifera* can hear low-pitch airborne sounds, up to 500 Hz, and that hearing such sounds plays a part in its dance communication. The receptor is in a joint in the pedicel of the antenna.

52.52 Communication by scent and taste

According to the author of *Historia animalium* Book IX: 'they say that, if a young swarm go astray, it will turn back upon its route, and by the aid of scent seek out its leader' (40.624a). Pliny (XI.17.54) also said that a bee could follow the leader by scent.

Huber (1792) carried out experiments which convinced him that bees have a very acute sense of smell, and also that: 'certain odours not only act physically, but have an influence on the inclinations of these insects: and here there doubtless commences a particular class of sensations eluding our researches, and of which we can form but a confused conception. What a variety of impressions are produced by smell on dogs of the chase!'

In 1965 the term 'pheromone' was introduced for a substance secreted by an animal which affects the behaviour of other individuals of the same species in a predictable way; the animals perceive the substance through olfactory or gustatory chemoreceptors. The word comes from Greek *pherein*, to carry, and *horman*, to excite. The first honey bee pheromone to be identified, which acts as a sex attractant to drones, was 9-oxo-2-decenoic acid from the queen's mandibular glands, and Butler *et al.* (1959) named it 'queen substance'. Pheromones were later found to be a primary means of communication between the bees, for instance between a queen and workers. They form the basis of the coherence and organization of the honey bee colony and of the queen's key position in 'controlling' these. Some 60 compounds produced by queen, worker or drone honey bees have so far been identified as pheromones or their components (see Crane, 1990a).

52.53 Communication by 'dancing'

The earliest description I know of dances by bees is in a manuscript about scout bees in a clustered swarm, by John Evelyn in England around 1655, which was not published until 1965 (D.A. Smith).

> Being too full and numerous, they [bees in a hive in June] send forth new *Colonies*; but first they who are assigned for the expedition resort together about the Hive 'till their King having found fit a place for their *Rendez-vous* first lights himself. Then immediately followed with innumerable numbers pitching their camp round about their Royal General they hang together, till certain scouts which before they had sent forth *tanquam exploratores* bring them tidings of a convenient quarter. Which notice he gives them by a certain touch which he imparts to the out guards that by a kind of shivering motion communicate it to the whole swarm and centre bees in a moment; at which signal they dissolve the populous and moving cone and fly immediately to the place ...

In the 1900s it was discovered that, after 'scout bees' find a possible nest site for the swarm, they carry out dances on the surface of the swarm cluster rather similar to those of foragers (Lindauer, 1955). From these dances, the other bees learn the location of the nest site, and are able to fly together to it.

Book IX of *Historia animalium* includes a slightly relevant passage, after the statement that foragers visit only one kind of flower on each trip (Section 52.31): 'On reaching the hive they throw off their load, and each bee on his return is accompanied by three or four companions. One cannot tell what is the substance they gather, nor the exact process of their work' (40.624b).

In 1788, Ernst Spitzner in Germany observed a successful forager dancing on her return to a glass hive: 'Full of joy she twirls in circles about those in the hive, from above downward and from below upward, so that they shall surely notice the smell of honey on her; for many of them soon follow when she goes out once again. ... When I put some honey not far away on the grass, and brought only two of the bees to it, these made it known to the others in the manner described, and they came in great numbers to the honey.' Observations by Bonnier in France (1906) suggested that successful foraging bees might be able to communicate the location of their forage to other bees in the hive. E.R. Root in the USA (1908) said that beekeepers often saw bees dancing, and it was generally believed that this 'was a sign of joy that they have found pollen, and that they take this means to communicate the knowledge of it to their fellows'.

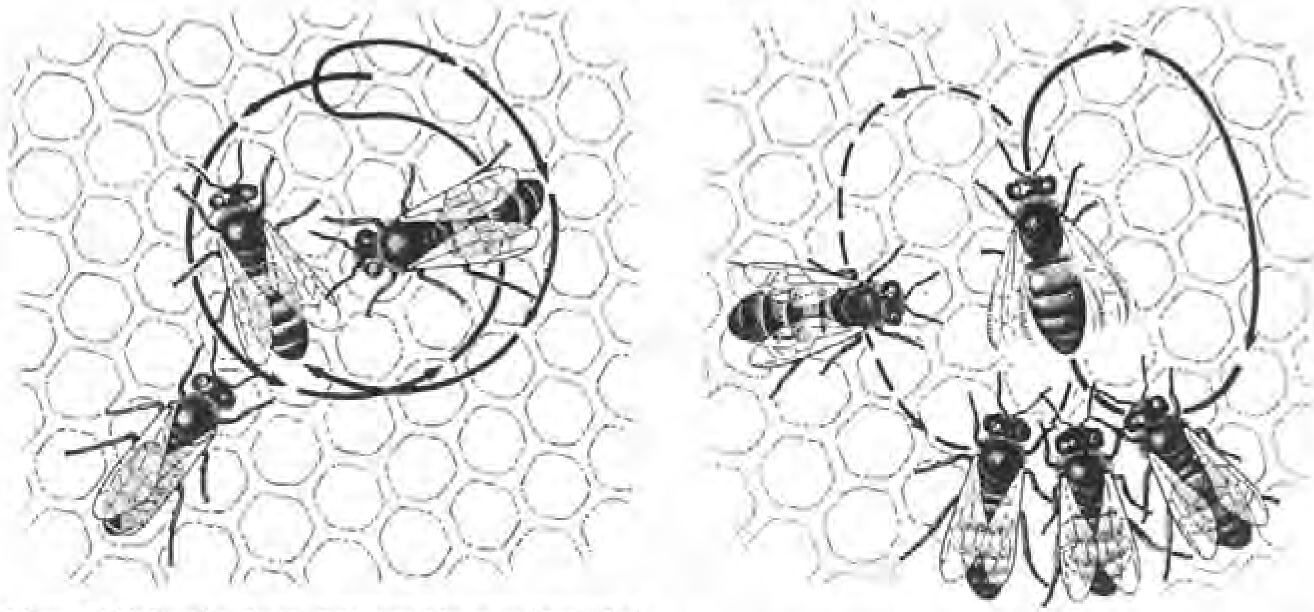


Figure 52.5b Round and wagtail dances of the honey bee studied from 1920 onwards (Frisch, 1969; redrawn by R. Lewington). The bee performing a round dance (*left*) is followed by two bees, and the bee doing a wagtail dance (*right*) by four.

Karl von Frisch (1920/22) studied the 'dances' systematically, and showed that a forager returning from a good source of food makes a repeated movement or dance on the vertical face of a comb, which other foragers follow attentively (Figure 52.5b), and they also learn the scent of the nectar carried by the dancing bee. If the food is less than 50-100 m away, a 'round dance' is sufficient to alert the other bees, and the bee moves in a circle, repeatedly reversing her direction. But if the food is farther away, the bee 'waggles' her abdomen and moves in a figure-of-eight (wagtail) dance (Figure 52.5b). From her movements other workers learn the position of the forage she has visited. The distance of the food is indicated by the tempo of the dance, and its direction by the direction of the straight run transposed to a vertical plane; upwards on the comb indicates the direction of the sun. In cloudy weather the dancing bee is able to learn the sun's direction by her perception of polarized light. Books by Frisch (1965 in German, 1967 in English) gave full details.

52.6 Life cycle and reproduction

52.61 Length of life, and sex, of individual bees

Length of life

It was known in the Ancient World that drones were produced in late spring, and that the bees killed or expelled them from the hive when the honey supply ceased, so drones lived only a few months. But the length of life of workers and queens was probably not understood until the 1890s.

According to Aristotle (*Historia animalium* V.22.554b): 'The bee lives for six years as a rule, as an exception for seven years.' Butler (1609) quoted this, but to him 'a [worker] Bee is but a yeares Bird'.

Determination of the length of life of a worker or queen was made possible by the development of techniques for marking individual bees. Müller (1882) used a spot of coloured paint to mark foragers he studied. A.I. Root (1895) was one of the first to use a genetic marker: he introduced an Italian queen (with yellow coloration) to a colony of black bees. If he introduced the queen in May or June, all black bees had died by the fall and only those with yellow bands were present. G.M. Doolittle added to Root's report the comment: 'They will live 45 days from three experiments I have tried.' If an Italian queen was introduced in September, some black bees were present until the following May. In Germany, Rösch (1925) marked 13 workers with paint in summer and checked their presence in the hive every day; he last saw them alive when they were between 20 and 55 days old.*

It was later found that bees in strong queenless colonies without brood in summer lived considerably longer than normal summer bees. Maurizio's (1950) experiments in Switzerland showed that during

*Huber had used paint to mark bees much earlier. In 1791 he described to Charles Bonnet how he introduced a queen after painting her thorax 'to distinguish her from the reigning queen' (Huber, 1841, p. 72).

their first few days adult worker bees normally feed intensively on pollen, which gives them the potential for a long life (many months). This potential is realized by bees living through the winter, but brood rearing depletes the bees' reserves built up through feeding on pollen, so in summer the bees live only a few weeks.

With regard to queens, A.I. Root (1895) said from his practical experience: 'Some queens die, seemingly of old age, the second season, but generally they live through the second or third, and we have had them lay very well, even during the fourth year.'

Sex of queen, drone and worker

In early times, most people who kept bees lived their own lives under a king, emperor or other male ruler, and they assumed that the single large bee in the hive was the male ruler of the rest. This bee had a shorter sting than the ordinary bees: 'the speere ... is but little, and not halfe so long as the other Bees: which, like a Kings sword, is borne rather for shew, and authority, then for any other use' (Butler, 1609). Appendix 1 quotes passages written in China *c.* AD 1000 which refer to the king or queen bee. However, in classical Greek texts praising bees was a rhetorical device with no implication of the sex of the large bee (footnote, p. 590).

In 1586 Luis Méndez de Torres in Spain was the first to state that the ruler was female and produced all other bees in the colony. Chapter 2 of his book started:

> Para entendimiento de lo que este capitulo promete, es de saber, que la aveja, que dizen *maessa*, o *maestra*, sin ayuntamiento de macho, y sin dolor, echa de si una semilla, de que se engendran tres generos de avejas, que son, maestras, y zanganos, y avejas. De suerte, que siendo la simiente una misma, por razon de la diversidad de los vasos donde se pone ...
>
> To understand what this Chapter deals with, it must be realized that the bee called the *maessa* or *maestra* [mistress], without coupling with a male* and without the pain of childbirth, produces a seed from which are engendered three kinds of bee – *maestras*, drones and ordinary bees – according to the different cells in which the seed is placed.

Between 1669 and 1673, by observing the reproductive apparatus under a microscope, Swammerdam in

*This is incorrect.

Figure 52.6a Reproductive apparatus of the queen honey bee, drawn by J. Swammerdam in 1669/73 and published in Plate 19 (1737/38). Part of the sting apparatus is below it.

the Netherlands established that the queen was female (Figure 52.6a) and the drone male. The accompanying text stated: 'The female lives in the hive for no other purpose, but to deposit, as occasion offers, her eggs in the cells. ... From one female, which is the only one of that sex in the whole hive, are produced all the three kinds of the bees.' Swammerdam also said: 'The common working Bees approach nearer to the nature and disposition of the females than of the males.' He continued 'they have no ovary*, and therefore, like women who have lived virgins till they age past child-bearing, serve only the purpose of labour in the economy of the whole body'. The male sex of the drone had been recorded by Charles Butler in England in 1609, but he believed (incorrectly) that drones mated with workers, which then laid eggs giving rise to both workers and drones.

Réaumur in France (1740) commented: 'Observations made more than 100 years ago [Méndez de Torres, 1586] showed that this bee ... which the Ancients called the King bee ... is a female. ... Swammerdam confirmed by incontestible evidence that this bee – which we may call the Queen – is a prodigiously fertile mother', and produces all bees born in the hive. In England, Thorley (1744) – presumably unaware that the answer had been known for 160 years – set out to decide whether the ruler bee was male or female by establishing whether what was placed in a cell was sperm or an egg. 'I have often proved, placing the Insect upon my Hand ... she has (moving upon it) laid several of these oblong Substances.' He observed further: 'It is most certain that the prolifick Substance or Matter, which is deposited in the Cells ..., and which after a few Days appears a little Worm or Maggot, proceeds from the Queen-Bee alone.'

I think it likely that the above facts were established independently in south-east Asia; a relevant passage in a 1773 Vietnamese encyclopaedia is quoted in Section 29.41.

The fact that the queen mates (outside the hive) was first demonstrated in 1771 (Section 52.62).

Origin of queen, drone and worker

It had been known for many years that if a colony was divided into two, the queenless part could rear a queen – provided it contained young worker brood or eggs (Jacob, 1658). Schirach (1770) in Württemberg showed that such queenless bees built queen cells round young worker larvae and reared these into queens; both queens and workers therefore developed from the same kind of egg. Dzierzon in Silesia, on the basis of his observations (1845a), proposed that after a queen has mated with a drone, she lays both fertilized eggs which give rise to females (queens or workers), and unfertilized eggs which give rise to male drones by parthenogenesis (they have a mother but no father; see the footnote in Section 36.51). The first volume of *American Bee Journal* (1861) published letters by Berlepsch, translated by Samuel Wagner: 'to defend his friend Dr Dzierzon against the assaults of those who ridiculed and derided the Dzierzon theory' of the production of drone honey bees by parthenogenesis. Finally, in 1913 Nachtsheim in Germany demonstrated that the drone has only 16 chromosomes (from his mother), whereas the queen or worker has 32 (16 from each parent).

The mechanisms that determine whether a female egg becomes a worker or a queen were unravelled later, as described by Beetsma (1979). It was stated in 1889 and demonstrated in 1925 that the differences between the worker and queen do not have a genetic basis, but result from differences in the quality and quantity of food the larva receives from nurse (worker) bees before it is 3½ days old.

The above paragraphs refer to European *Apis mellifera*, and they apply in principle to other *Apis*. There is one exception: in the Cape bee *A. m. capensis* in South Africa, certain workers can also lay eggs giving rise to queens capable of mating and then laying normal fertile eggs.

52.62 Mating

Mating flights of queens

The almost universal belief that the queen did not mate was disproved by Janscha's observations on young queens flying out from their hives and returning to them; these were published in 1771, and translated as follows by Fraser (1951b).

> In fine weather the queen will fly out on the third or fourth day, in bad weather up to the fourteenth. Accompanied by a great crowd of bees and drones, she will come out on the alighting board on a fine day between 9 am and 3-4 pm, turn round and round in order to mark the hive, whereby she may find it again on her return, and finally raise herself into the air; she will fly round the hive for a little while to look at it, and rise ever higher little by little. On her return, before she enters the hive, she flies for a while before it.

Janscha then explained how he was able to infer whether the queen had mated, by looking for the 'mating sign'.

> If the hinder pointed part of the abdomen, where the bees have the sting, is open; or something white, like a thin thread, hangs from it and it appears as though injured or torn, then the fertilization is undeniable. She will begin to lay eggs in five or six days.

In 1792 Huber added from his own observations that drones were already flying when the queen set out. One queen, having checked the hive's position, 'was away for 27 minutes and returned [with] the

organs distended by a substance, thick and hard: she carries away the genital organs [of the male]'. He wrote of another returning queen: 'the last ring of the body was open, and the organs full of the whitish substance already mentioned'. With the assistance of Burnens, Huber found semen in the vagina of a queen which had returned to her hive carrying the 'mating sign'. Some later observations on queen flights are included under *The mating process* below.

Drone congregations

Drone mating flights were not understood until the late 1900s when drone assemblies or congregations were intensively studied. In these, dozens or hundreds of drones fly fairly close together above a certain piece of land, usually during early afternoon when queens are likely to fly out to mate. Occasional statements had been made in the past which might refer to drone congregations. For instance Gilbert White in England wrote on 9 July 1779 in his *Journals*: 'A surprising humming of bees all over the common, tho' none can be seen. This is frequently the case in hot weather.'

The earliest clear description found of a drone congregation was written in 1892 by Cromley in the USA.

> I think that drones have a certain place to congregate, and their noise attracts virgin queens that may be on the wing at the time, and they go to these places and are fertilized. I have discovered two places that they congregate in great numbers, about $\frac{1}{4}$ mile from my apiary. Go there when I will, when the drones are flying, and I can find the air full of them, over a space of two acres. If I stand between my apiary and the place of congregating, I can see the drones coming and going continually.

Drone congregations seem to have aroused little interest until Jean-Prost observed them in the south of France on 31 July 1955 and described them in detail (1957, 1990). Cooper (1986) listed drone congregation areas known in Britain.

Drone behaviour prior to mating

When a queen flies in the vicinity of the drones they chase her, keeping in rather a close formation. This was observed by Hannemann in Germany on 6 July 1849 and described in *Bienen-Zeitung* (1850); see Figure 52.6b. Langstroth quoted the article in the first volume of *American Bee Journal* (1861a), with Hannemann's figures redrawn.

Figure 52.6b Sketches of flying drones chasing a virgin queen, 1849 (Hannemann, 1850). They were redrawn in *American Bee Journal* (1861); see text.

> While sitting in the shade of a tree, about thirty paces from the apiary, my attention was attracted by an unusually loud humming. Suddenly I saw some twenty or thirty drones in rapid pursuit of a queen bee, at an elevation of 25 or 30 feet from the ground. The cluster occupied a space apparently two feet in diameter, and in their course sometimes sunk to within ten feet of the ground, and then rose again, passing from north to south. I followed them about 100 paces, and then lost sight of them behind an intervening building. While they were thus pursuing the queen, the cluster presented this appearance except when it approached the ground, the mass became more condensed and circular ... Before they vanished from my sight the queen made her escape from among the encircling drones by a sudden turn, and I saw her distinctly shooting ahead, and rising higher in the air, the drones in full pursuit.

By tethering a virgin queen high in the air, Gary in the USA (1963) was able to photograph the 'comet' of drones approaching her (Figure 52.6c); this comet is strikingly similar to what Hannemann drew over a hundred years earlier.

The mating process

Neither Janscha nor Huber saw a queen and drone mating, although both knew that a queen leaves her hive and returns carrying part of a drone's genitalia which had become detached as a result of the mating (the mating sign). Huber believed that eggs laid by a queen during her whole life were fertilized after a single mating. It was later established that the

Figure 52.6c Photograph of a 'comet' of 18 flying drones chasing a tethered virgin queen moving through the air (photo: N.E. Gary). Part of the equipment is on her right.

queen is likely to mate with a number of drones during a single mating flight; see below.

Langstroth (1861a) quoted two first-hand descriptions of a mating queen and drone which fell to the ground and could be studied. The Rev. Mr Millette of Whitemarsh, PA, had written in *Farmer and Gardener* for November 1859:

> In the month of June, one of the queens [from an after-swarm] was observed on the wing, and in a moment after was seized by a drone. After flying about a rod [5 m], they both came to the ground in close contact; the writer instantly followed them up, and as the drone was about departing (having broken loose) seized both the bees, the queen in one hand and the drone in the other. They were taken into the house and left at liberty to fly, when the queen flew to the (closed) window, but the drone after crawling about on the hand, was laid upon the window seat and in a very few minutes expired. Both the queen and the drone had a white milky fluid upon the extremity of the abdomen, and upon pressing the drone, there was no indication of his possessing the speciality of his sex.

Mr Wm W. Carey of Coleraine, MA, described a rather similar experience at about 3 pm on 6th July 1860. He and a friend both distinctly heard an explosion just before the pair separated, 'the drone falling to the ground perfectly dead, and its abdomen very much contracted. The queen, after making a few circles in the air, entered the hive with the male organ of the drone attached to her.'

In 1934 Betts summarized what was then known about mating flights and the mating process, and included a chronology of 37 observations and discussions from 1856 onwards. Fyg (1952) brought knowledge of the mating process itself up to date, and published the best drawings of the reproductive systems then available.

Gary (1963) in USA made the first systematic close-up observations of the positions of the queen and drone mating (Figure 52.6d); he used queens tethered to a line strung high up between two television masts. A close-up film of the mating was made by G. Koeniger *et al.* (1979), by fitting a ciné camera to the inner end of a rotating arm at the top of a pole; a queen was tethered to the outer end, so that she remained within the field of the camera while 'in flight'.

In the 1940s and early 1950s evidence from several countries showed that a queen mates with a number of drones, usually during the same flight. For instance it was found that when the queen returned to the hive, her spermatheca contained far more semen than one drone could produce; Ribbands (1953) gave some details. Then in 1955 Alber *et al.* published experiments made on the island of Vulcano near Sicily, where the only honey bees were those of different races taken there for the experiments. Observations on the returning queens and their progenies showed that a single queen must have mated with drones of more than one race. Later observations suggested that, in good weather, a queen of European *A. mellifera* is likely to mate with ten or more drones in quick succession, during a single flight.

52.63 Swarming

Section 44.21 describes the swarming process in a colony, including the rearing of new queens. Some of the facts about it were known in Ancient times, for instance that bees build cells 'for the kings only when the brood of young is numerous' (*Historia animalium* IX.40.624a). Varro wrote (III.16.29):

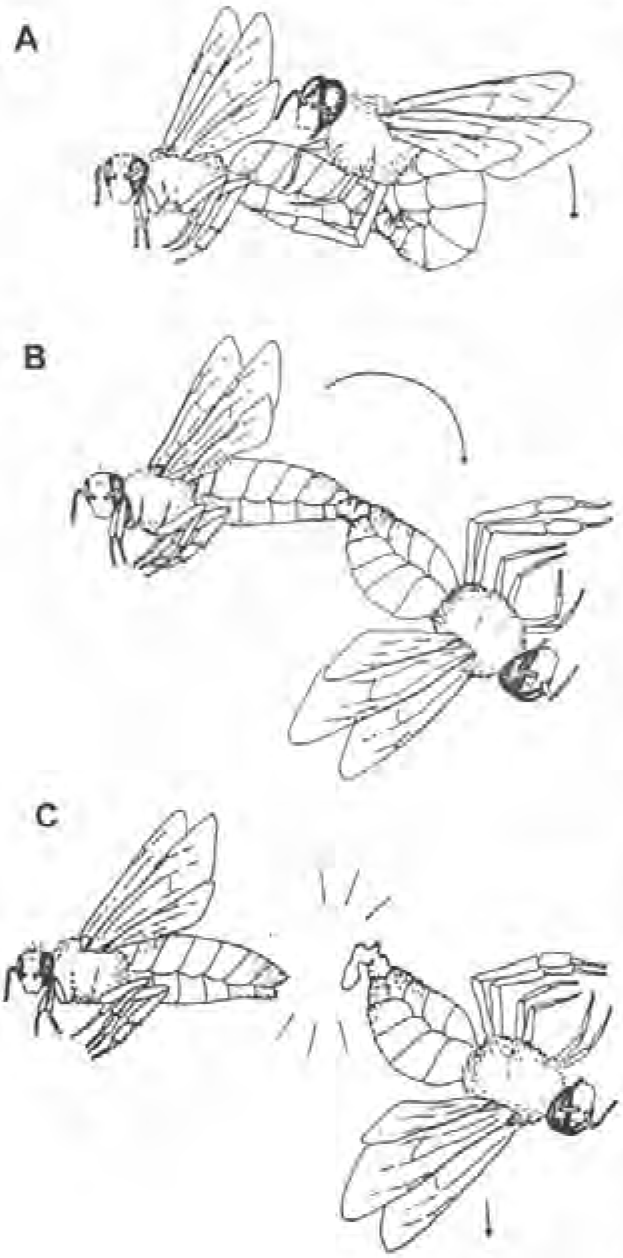


Figure 52.6d Positions of the queen (*left*) and drone (*right*) during the mating process (Gary, 1963). **A** Initial mounting position; **B** Intermediate position; **C** Drone separated, showing part of the everted genitalia.

> The time when the bees are ready to swarm ... generally occurs when the well hatched new brood is over large ... On preceding days, and especially in the evenings, numbers of them hang to one another in front of the entrance, massed like a bunch of grapes. ... when they are getting ready to fly out or even have begun the flight, they make a loud humming sound exactly as soldiers do when they are breaking camp.

The behaviour of swarms was described in terms of kings and chiefs, each with factions of followers which sometimes fought each other, and Columella said: 'If, however, you have often noticed them fighting a pitched battle, you will take care to put to death the leaders of the factions [young virgin queens]' (IX.9.7). But it seems likely that beekeepers in Ancient Greece and Rome did not distinguish between prime swarms and afterswarms, and did not kill surplus virgin queens within the colony to prevent afterswarms issuing.

Beekeepers in early mediaeval Ireland and Wales were very familiar with the life cycle of colonies, and swarms were an integral part of their beekeeping system (Section 27.52). An Irish text probably dating from the 600s/700s referred to colonies in 'the year of their origin, the year of their scarcity [containing few bees], and the year of their multiplying [swarming]'. By the 1200s, beekeepers in Wales used specific names for seven kinds of swarms, based on the sequence in which these issued, and for colonies before and after swarms issued from them (Table 27.5A). Different kinds of swarms were also recognized in other countries where swarm beekeeping (Section 27.11) was practised, and unpublished notes made by A.D. Betts in the 1920s recorded specific names used in various English counties for four successive afterswarms: for instance cast, colt, bunt and screw.

Janscha's 1771 book on swarming described the process itself in detail, as well as beekeepers' appropriate actions. He stated from experience that the prime swarm contained the queen of the colony from which it issued, and that the colony itself was subsequently headed by a young queen. Huber's (1792) observations using a glass hive holding three combs confirmed that the old queen went with the swarm, and he showed further that young queens went off with afterswarms.

52.7 Parasites and diseases of honey bees

52.71 Before the causative organisms were known

Beekeepers in the Ancient World noticed that bees suffered from various disorders, and Section 23.11 refers to Aristaeus, the mythical inventor of beekeeping in Ancient Greece, whose bees were made sick by a dryad. Przychodzki (1976) published a full account

Figure 52.7a Bees flying from three skeps in a simple shelter in Prussia, with mice in the foreground (Konrad von Megenberg, *Buch der Natur*, 1475).

of bee diseases according to Greek and Roman authors. Between 330 and 30 BC Aristomachus, referred to in Section 23.13, said that the following help should be given to bees which are sick: 'first, all the diseased combs should be removed and entirely fresh food placed for the bees, and then they should be fumigated.' Columella (IX.13.8) quoted Aristomachus' comment from the book by Hyginus, but both these texts are lost.

Disorders recognized in Ancient Greece included starvation, dysentery, and failure to rear brood. 'Another diseased condition is indicated in a lassitude on the part of the bees and in malodorousness of the hive' (*Historia animalium* IX.40.626b), which may refer to the bacterial infection later known as European foul brood (Table 52.7A); Fraser (1958) suggested that it was the same as the 'murrain' of bees in England in the 1600s. Columella (IX.5.3) referred to 'health-giving herbs and ... other remedies which may be applied to bees when they are sick'.

In the Ancient World it was easier to take action against 'bee enemies' large enough to be seen: insects, amphibia, birds and mammals; see *Historia animalium* IX.40.626a, 627b, and Pliny XI.29.62. A woodcut from 1475 (Figure 52.7a) shows mice in front of three hives.

Wax moth larvae which damage combs were also visible to the naked eye. According to *Historia animalium* (IX.40.625a), if bees fail to brood over their combs, 'the combs are said to go bad and to get covered with a sort of spider's web. ... In the damaged combs small worms are engendered, which take on wings and fly away.' Columella recommended smoking the combs in spring (so that both larval and adult moths dropped off them), and also setting up light-traps near the hives at night in autumn to attract adults – which were then thrown on the fire. This activity was later portrayed by a Flemish artist (Figure 52.7b).

There are a few later references to diseases or

Figure 52.7b Flemish beekeepers in their apiary at night, with lanterns to attract and kill wax moths, by Jan van der Straat, c. 1590.

deaths of bees during the centuries before it became possible to identify the pathogens. The Annals of Ulster mentioned 'a mortality of bees' in Ireland in 951, and again in 993 (Section 27.52). A disease that was probably American foul brood was referred to in Germany by Jacob (1568), in England by Remnant (1637) – who advised cutting out comb containing diseased brood – and in Syros in the Aegean by della Rocca (1790). Gnädinger (1975) gave some details.

In a passage reprinted from Rees's *Encyclopaedia* in 1841, Huber referred to three 'distempers' of bees. Of these, dysentery in spring – which often proved fatal – was blamed by some on the long winter confinement in the hive, but by Mme Vicat (1764b) on honey in the cold hive having granulated. Huber regarded the passage by Aristomachus quoted by Columella (above) as referring to treatment of this 'distemper'. According to him, an excellent restorative was to feed the bees with a syrup made of equal quantities of good wine and sugar. A second, incurable distemper which appeared about the end of spring was called *vertige* (vertigo) by Ducarne de Blangy in 1771; the bees' flight was marked by 'involuntary startings, falls, and other gestures'. In a third distemper from which bees sometimes suffered, their antennae had a swelling at the extremity. They lost their vivacity, languished and died; French beekeepers used Spanish wine as a treatment. A disorder in which larvae died was also mentioned.

52.72 Discovery of the causative organisms

The causative organisms of almost all bee diseases were identified after 1900, when the necessary advances in microbiology had been made, and appropriate techniques and equipment were available. Table 52.7A gives some details of the first identification of the causative organism of some important diseases of *Apis mellifera*, and also of parasitic mites of various *Apis* species. References to original publications and details of subsequent research work are in books by Bailey (1981) and Morse and Nowogrodzki (1990); both refer to still other diseases and parasites of *A. mellifera*, and the second also to those of other *Apis* species.

Table 52.7A

Diseases and parasitic mites of *Apis mellifera*

The entry gives the date of identification of the causative organism, who first identified it and his country, and the current name of the organism if different. Organisms marked * also infect *Apis cerana*.

Bacterial diseases	
1885	European foul brood: *Bacillus alvei**, F.R. Cheshire & W.W. Cheyne, England (since 1982, *Melissococcus pluton*)
1907	American foul brood: *Bacillus larvae**, G.F. White, USA (since 1993, *Paenibacillus larvae*)
1928	septicaemia: *Bacillus apisepticus*, C.E. Burnside, USA (since 1959, *Pseudomonas apiseptica*)
Protozoan diseases	
1909	nosema disease: *Nosema apis*, E. Zander, Germany
1926	amoeba disease: *Malpighamoeba mellificae*, H. Prell, Germany
Fungal diseases	
1906	stone brood: *Aspergillus flavus* and other species, A. Maassen, Germany
1916	chalk brood: *Ascosphaera apis**, A. Maassen, Germany
Viral diseases	
See Bailey (1981, 1982); Morse and Nowogrodzki (1990).	
Mites (Acari) parasitizing *A. mellifera* and other *Apis* species	
1904	*Varroa jacobsoni* Oudemans, found on *A. cerana* (Java) by A.C. Oudemans, Netherlands; it transferred to *A. mellifera* near Pacific coast of USSR by the early 1960s.
1921	tracheal mite, known earlier as acarine mite: *Acarapis woodi*, found on *A. mellifera* by J. Rennie *et al.*, Scotland, who used the name *Tarsonemus woodi*, but in the same year S. Hirst corrected this to *Acarapis woodi*. *Acarapis woodi* was found during searches for the cause of 'Isle of Wight disease' which was believed to account for many colony deaths in the early part of this century, especially in Britain; see *Bee World* (1974). *Acarapis woodi* parasitized *A. cerana* in India by 1957.
1961	*Tropilaelaps clareae*, found on *A. dorsata* by M. Delfinado and E.W. Baker, USA; 1962 on *A. mellifera*, Philippines.
1974	*Euvarroa sinhai*, found on *A. florea* (India) by M. Delfinado and E.W. Baker, USA.
1982	*Tropilaelaps koenigerum*, found on *A. dorsata* (Sri Lanka) by M. Delfinado-Baker and E.W. Baker, USA.
1987	*Varroa underwoodi*, found on *A. cerana* (Nepal) by M. Delfinado-Baker and K. Aggarwal, USA.

52.8 Species and races of honey bees

Umasvathi, a Jain biologist who lived in India between 100 BC and AD 100, made an attempt to classify insects by dividing them into four groups according to the number of their senses. Bees and wasps, which had four senses (sight, smell, taste and touch), were in his Division 3 (Sinha & Shankarnarayan, 1955).

Real advances in systematics started in the 1700s; Tuxen (1973) summarized those between 1700 and 1815 and Lindroth (1973) those between 1800 and 1859. Carl von Linné (Linnaeus) in Sweden developed a system for plants and animals based on their morphological structure, which is still the basis of biological classification. It was first published in his *Systema naturae* (1735) and republished in many editions. The 10th (1758) was later chosen by the

International Rules of Nomenclature as the date after which properly applied names could no longer be altered. It is unfortunate that up to this edition Linnaeus used the name *Apis mellifera* (the honey-bearing bee) for the European honey bee. In the light of later knowledge he improved it to *Apis mellifica*, the honey-making bee, but according to the International Rules the earlier name had to be retained.

Investigations after 1800 showed that there were a number of regional subspecies/races of each of the honey bee species (*Apis*). Any subspecies or race was often given different names by different authors, and there were other complications. Tsing-Chao Maa in Taiwan gathered together this tangled information during a period of 15 years, and published a detailed study on the systematics of honey bees (Maa, 1953). Table 52.8A gives recently accepted names of the species and subspecies/races, with their authorities, and Figures 3.2a and 3.4a show the distribution of four *Apis* species.

Table 52.8A

Species and subspecies/races of *Apis*

Based on Ruttner (1988) and Otis (1994). Entries are in date order of the first use of the name now regarded as valid.

Scientific name and authority	*Common name (or Section)*	*Country of author*
Apis mellifera Linnaeus 1758		
mellifera Linnaeus 1758	common European black	Sweden
adansonii Latreille 1804	§§ 28.4, 28.5	France
unicolor Latreille 1804	§ 28.7	France
ligustica Spinola 1806	Italian	Italy
capensis Eschscholtz 1822	Cape, § 28.6	Germany
scutellata Lepeletier 1836	§§ 28.3, 28.5, 28.6	France
cecropia Kiesenwetter 1860	§ 23.1	Germany
carnica Pollmann 1879	Carniolan	Germany
cypria Pollman 1879	Cyprian	Germany
intermissa Buttel-Reepen 1906	Tellian	Germany
lamarckii Cockerell 1906	Egyptian	UK
syriaca Buttel-Reepen 1906	Syrian	Germany
sicula Montagano 1911	Sicilian	Italy
caucasica Gorbachev 1916	grey mountain Caucasian	Georgia
saharensis Baldensperger 1922	Saharan	France
armeniaca Skorikov 1929	yellow Armenian	USSR
meda Skorikov 1929	Persian	USSR
taurica Alpatov 1938	Crimean	USSR
anatoliaca Maa 1953	Anatolian	Taiwan
litorea [F. G.] Smith 1961	§ 28.3	Tanzania
monticola [F. G.] Smith 1961	§ 28.3	Tanzania
iberica Goetze 1964	Iberian	Germany
adami Ruttner 1975	(Cretan)	Austria
jemenitica Ruttner 1975	§ 21.3	Austria
macedonica ssp. nova (Ruttner, 1988)	Macedonian	Austria
Apis florea Fabricius 1787	§ 3.5	Denmark
Apis cerana Fabricius 1793	§ 3.3	Denmark
cerana Fabricius	§ 3.3	Denmark
indica Fabricius	§ 3.3	Denmark
japonica Radoszkowski 1877	§ 3.3	Poland
Apis dorsata Fabricius 1793	§ 3.4	Denmark
Apis andreniformis [F.] Smith 1858	§ 3.5	UK
**Apis nigrocincta* [F.] Smith 1861, in Sulawesi, Indonesia		UK
Apis laboriosa [F.] Smith 1871	§ 3.4	UK
Apis koschevnikovi Buttel-Reepen 1906	§ 3.3	Germany
Apis binghami Cockerell 1906	§ 3.4	UK
Apis breviligula Maa 1953	§ 3.4	Taiwan
**Apis nuluensis* Tingek, Koeniger & Koeniger 1996, in Sabah, Malaysia		Malaysia, Germany

* published in *Apidologie* 27(5), 1996

52.9 Substances collected or produced by honey bees

Worker bees collect nectar and honeydew (from which they make honey), also pollen and propolis. They secrete beeswax, venom and brood food, including royal jelly which is fed to the queen and to queen larvae. Sections below summarize the growth of knowledge about these substances, and Chapter 51 deals with them as bee products harvested by man.

52.91 Substances collected

Section 52.31 explained early knowledge about the bees' collection of substances from plants; the idea that wax was collected from plants was wrong (Section 52.10).

Nectar and honeydew

In the Ancient World both these words were used for a sweet, desirable liquid, sometimes referred to as food of the gods. Until the 1700s it was believed that the sweet liquid collected by bees fell from heaven on to the flowers. For instance Charles Butler said in 1609:

> The greatest plenty of purest nectar cometh from above; which Almighty God doth miraculously distil out of the air .... the very quintessence of all the sweetness of the earth, drawn up, ... and condensated by the nightly cold into this most sweet and sovereign nectar, which thence doth descend into the earth in a dew or small drizzling rain.

It was discovered later that nectar does not fall from the skies, but is produced in the nectaries of flowers. Several writers, including Bonnier (1879), cited Vaillant's 1717 lecture on the structure of plants as stating the origin of nectar and giving the name *mielliers* to nectaries, but the text, published in 1718, does not mention organs producing nectar (Courant, 1996). In England, John Hill wrote in 1759: 'It is produced within the flowers, where it is found.' Bonnier's 1879 thesis was on nectaries; most of these are in flowers, but a few are extrafloral – on a leaf or stalk. Nectar from many flowers contains between 20% and 50% sugar, the main sugars being sucrose, fructose and glucose in various proportions (Planta, 1886). Pryce-Jones (1944) discussed problems then outstanding in the elucidation of nectar and honey, and also pollen.

Honeydew is a liquid produced from plant sap by plant-sucking insects. It contains a wider variety of sugars than nectar, and is collected by bees, wasps and ants from wherever the insect deposits it on leaves and stalks. Réaumur (1739) in France first noted the occurrence of aphids and honeydew together, and realized that the honeydew was excreted by the aphids. Abbé Boissier de Sauvages (1763) described the nature and production of honeydew, and Büsgen (1891) further elucidated the complex processes involved.

Pollen

A foraging honey bee collects pollen from flowers and, to carry it home, she packs it into pellets on special hairs on her two hind legs. In Ancient Greece these pellets were generally assumed to be beeswax, but the author of *Historia animalium* Book IX observed correctly that the bees 'store up another article of food resembling wax in hardness, which by some is called *sandarace*, or bee-bread'. This 'they carry on their legs' (40.626a, 623b).

The name bee bread persisted for many centuries, perhaps because it was the only solid food that bees consumed. An Anglo-Saxon Psalter written in about 825 mentioned the sweetness of *hunig* and *biebreed*. 'Pollen' (a Latin word for fine flour, meal or dust) was first used as an English word by John Ray in *Historia plantarum* (1686). But an earlier word *farina* (Latin for flour) continued in use for some years afterwards, for instance by Dobbs (1750) in Ireland. He stated clearly that farina is the 'male seed' of the flower which fertilizes the ovum, and that honey bees collect it from only one kind of flower on a single flight (Section 45.3).

Maurizio (1950) showed that pollen is an essential food for young adult workers which secrete brood food for larvae, and that a lack of it shortens their lives. Pollen is the bees' only source of protein, vitamins and other substances essential for development both before and after emergence from the cell as an adult; see Section 52.61, *Length of life*.

Propolis

Sections 51.5 and 52.31 quote references to propolis in Ancient writings. The first use of the word 'propolis' in an English text was by John Trevisa in 1398 (*OED*), and in a French text by Ambroise Paré, surgeon to Kings of France in the 1500s (Debuyser, 1984).

As late as the 1920s there were many arguments as to whether propolis was a plant or bee product. Philipp (1928) and some others claimed incorrectly that the bees themselves produced one kind of propolis by regurgitating undigested parts of pollen grains; Ribbands (1953) gave some details. In fact propolis consists of plant secretions and exudates. Since 1900 attempts had been made to establish the composition of propolis, and Ghisalberti (1979) published results of nine analyses made between 1908 and 1947. These varied widely, partly because secretions or exudates from many plant sources may constitute any one sample of propolis; also bees may mix beeswax with it. In all the analyses, the main components were resin and wax, others were described as balsams, volatile oils, and components soluble or insoluble in alcohol. Ghisalberti discussed 24 components identified by 1979; by 1987 (Walker & Crane) 149 were known, including 38 flavonoids, compounds probably responsible for antimicrobial properties of propolis.

52.92 Substances secreted

Beeswax

The fact that beeswax is a secretion from worker bees themselves, and not collected by them, was first understood in the 1700s (Section 52.42). In 1848 Sir Benjamin Brodie stated that beeswax consisted mainly of cerotic acid, myricine, and a small amount of 'ceroleine'. Hehner (1883) found it 'remarkably constant in composition', with 86-89% of myricine. Callow (1963) quoted the current definition by the Pharmaceutical Society of Great Britain: beeswax 'largely consists of the ester of palmitic acid with myricyl alcohol'; in greater detail, it 'contains 72% of esters, the chief of which is myricyl palmitate, together with free wax acids, cholesteryl esters and

pollen pigments'. Gas-liquid chromatography was then being developed, and in the same paper Callow published chromatograms which identified the hydrocarbons present by the number of their carbon atoms. Because beeswax is a secretion, it has a much greater uniformity in composition than honey, which is made by bees from nectar secreted by a great variety of plants.

Tulloch (1980) studied beeswax from several honey bees, and found slight differences between them (Figure 52.9a).

Royal jelly

Swammerdam (1737/38) described the remains of brood food in queen cells which, 'on pouring water upon it, looked like soft starch or gum tragacanth, beginning to swell; it was of the colour of pure amber, and of a somewhat subacid flavour'. Réaumur used the terms *bouillie* (pap) and *gelée* (jelly) interchangeably for the food of queen and worker larvae. Huber (1792) applied these terms only to worker brood food, and *gelée royale* (royal jelly) to the food of queen larvae, which he described as white to yellow, thick or paste-like, acid, with a distinct aroma and sharp taste.

Langstroth (1853) seems to have been the first to get a chemical analysis done, by Dr C.M. Wetherell in 1852. Analytical methods then available gave little information, and the same was true in 1888 when Planta in Germany analysed royal jelly. Johansson and Johansson (1955, 1958) recounted the history of knowledge about the composition of royal jelly up to the 1950s; advances were made by Aeppler in USA in 1922 and Elser in Germany in 1929; then in 1940 Townsend and Lucas in Canada separated royal jelly into four fractions, and in 1949 Pratt and House in USA determined the amino acids in it. Much has been discovered since 1958, and more recent analyses quoted by Crane (1990a) gave an approximate gross composition: water 67%, proteins 11%, sugars 9%, ether extract 6%, ash 1%, and also small amounts of enzymes and vitamins, etc.

Bee venom

Effective studies on the composition and action of bee venom started in the mid-1900s, especially by Habermann and others at the University of Würzburg in Germany (see Neumann & Habermann, 1954). The venom was separated by electrophoresis into three fractions F0, FI and FII. No biological activity was found for F0; FI (only) was toxic and showed effects on muscular and other systems; FII (only) contained

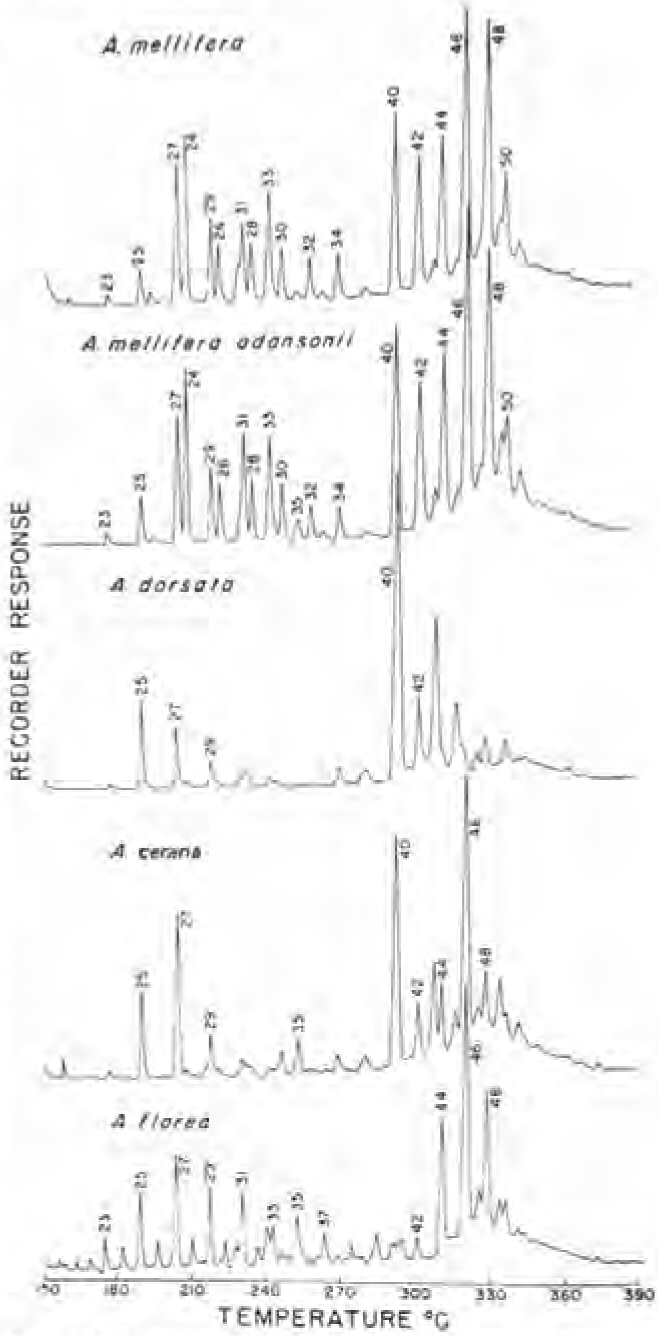


Figure 52.9a Gas-liquid chromatographic analysis of beeswaxes (Tulloch, 1980). Odd numbers 23-35 are hydrocarbons; even numbers 24-34 are free acids (as methyl esters) and 40-50 are monoesters. *A. mellifera adansonii* should read *A. mellifera scutellata*.

hyaluronidase, and inactivated thromboplastin and dehydrogenases. By 1984 the following had been found in bee venom: enzymes including hyaluronidase and phospholipase A_2; small proteins and peptides including adolapin, mellitin, and MCD or

401 peptide; physiologically active amines including apamine, histamine and dopamine; also two amino acids. Crane (1990a) gave fuller and later information.

Concepts of allergy (hypersensitivity) to venom and anaphylaxis were formulated early in the 1900s. Riches (1982) explained different types of hypersensitivity to bee venom – and the methods of diagnosis and treatment used – and also cited reports of its incidence in the 1970s.

52.93 Honey

Until the 1800s it was believed that honey bees collected honey from plants and stored it unchanged. In 1853 Langstroth referred to bees gathering honey from flowers and also getting it from honeydews, and in 1880 A.I. Root still used the words nectar and honey as synonyms for the sweet liquid secreted by flowers. But from the mid-1800s advances in chemistry made it possible to determine the composition of honey; for instance the sugars glucose and fructose were isolated and named, in 1838 and 1864 respectively (*OED*). Procedures for analysing sugars were developed by Fehling between 1846 and 1865. The nature and function of enzymes were discovered by the late 1880s (Section 52.44), and in 1888 Cheshire was able to say that 'the blossoms whence the bees gather nectar yield mostly cane sugar, but this undergoes inversion through the action of the salivary secretion of the bee'. It was established in 1931 that the bees add to nectar certain enzymes (from their hypopharyngeal glands) which change its sugar composition (Section 52.44). The amounts of the four main components of a large number of honey samples from four countries (Crane, 1990a) were:

	Range	*Average*
water	13-26%	17.0%
fructose	22-54%	39.3%
glucose	20-44%	32.9%
sucrose	0-8%	2.3%

Acids (especially gluconic), minerals, amino acids and proteins, enzymes and aroma components, constitute no more than 1% of the honey.

In the late 1800s, imported honeys were sold in some European countries at a much lower price than home-produced honeys, and beekeepers therefore sought methods to identify imported honeys. In 1895 Pfister suggested that the geographical origin of a sample of honey might be established by identifying the grains of pollen found in it; these vary in size and structure according to their plant origin. Faraut (1909a), working in Annam which is now in Vietnam, made the same suggestion. During the 1930s-50s, 'pollen analysis' of honey, melissopalynology, was developed in Europe, especially in Germany and Switzerland (Maurizio, 1975). Although the initial purpose of this work was economic, from the 1960s it was also used widely in scientific studies on plant sources of honeys in different parts of the world.

52.10 Annex: Misconceptions about bees, dating from the Ancient World

Bugonia, ox-born bees

One misconception about bees in the classical world was that they were spontaneously generated in the fresh carcass of an ox which had been killed in a specific way. The process was referred to as *bugonia*, progeny of an ox: the life of the ox passed into the life of the bees. This was not an isolated concept; according to related beliefs, drones were generated from horses, hornets from mules, and wasps from asses (Davies & Kathirithamby, 1986).

The procedure for generating bees was described in the story of Aristaeus, the mythical Greek inventor of beekeeping (Section 23.11), and Ransome (1937) summarized Virgil's instructions in lines 295-314 of the Fourth of his *Georgics*.

> Choose a small confined space, and erect in it a building with four windows, one facing each quarter, and with a tiled roof. Then take a bullock, whose second year's horns are just curling over its brow, stop up its nostrils and mouth and beat it to death without breaking the skin. Shut the bruised body up in the closed room, strewn with thyme and cassia, and after nine days the softened bones having fermented, wondrous creatures will appear, who with buzzing wings will fly into the air – a swarm of bees.

Figure 52.10a shows an imaginary portrayal of bees leaving a dead ox.

The mythology associated with the belief has been discussed by Cook (1895), Ransome (1937) and Davies and Kathirithamby (1986). Suggestions were that the practice had its origin in Egypt, where there was a custom of burying dead oxen in a section of the Nile delta. The idea that bees were generated may have arisen from a confusion between larvae of honey bees and those of blowflies (*Calliphora* spp.), or flesh-feeding flies, Sarcophagidae (Bérubé, 1991), or

Figure 52.10a An imaginary picture of a newly generated swarm of bees leaving a dead ox (from the same source as Figure 52.5a).

between adult honey bees and drone-flies, *Eristalis tenax*, whose larvae feed on decaying organic material (Osten-Sacken, 1894, 1895). According to Florentinus in *Geoponica* (AD c. 950), the king bee came from spinal marrow – or better still from the brain – and ordinary bees from the flesh of the ox.

The belief spread to the Greek World in Hellenistic times – hence its absence from Aristotle's works; Greek writers who lived in Alexandria in the Ptolemaic period (304-30 BC) described *bugonia*, and Antigonos of Karystos in Euboea (c. 250 BC) wrote: 'In Egypt if you bury an ox in certain places, so that only the horns project above the ground, and then saw them off, they say that bees fly out; for the ox putrefies and is resolved into bees.'

In Roman times Columella said that 'bees can be generated at this same time of year from a slain bullock. Mago indeed also asserts that the same thing may be done from the bellies of oxen, but ... I am in agreement with Celsus ... that it is [not] necessary to procure them [bees] by this means' (IX.14.6). Other Roman writers referred to *bugonia* as a fact, and Virgil's name carried such weight in and after mediaeval times that the *bugonia* story believed by him was accepted unhesitatingly. It also had support from such great Christian writers as Origen and St Augustine. Shakespeare wrote in *Henry IV, Part II* (c. 1599): 'tis seldom when the bee doth leave her comb, in the dead carrion ....' On page 2 of his 1655 book, Hartlib told how 'old Mr Carew' in Cornwall produced bees by the method, and *Dictionarium rusticum et urbanicum* (1704), also in English, devoted a page to it as if it were true.

Misconceptions in Historia animalium

Aristotle wrote more extensively about the life of the bee than any known predecessor, and without his writings knowledge about bees during the next two thousand years would have been very much poorer. He was a versatile observer, although opinions differ on how many of his statements were based on his own experience; by his lifetime there was already a considerable body of belief about bees – some of it true and some not – and he would have been familiar with this. It is not surprising that certain of Aristotle's statements were untrue. His writings were in the form of notes, and his students may well have added to them during the 270 years between his death and their publication (V. Liakos; see Nikiti, 1996). Aristotle can never have intended – or even conceived – that the ideas he recorded would become elevated in the Middle Ages to what Medawar and Medawar (1984) called a 'doctrinal tyranny'. Aristotle's texts on bees have been reviewed critically by several other recent authors (Jones *et al.*, 1973; Morge, 1973; Byl, 1976, 1980; Davies & Kathirithamby, 1986); the 1986 book also discussed the earlier assessments and quoted still others. Fraser (1951a) wrote in detail about Aristotle's remarks on both bees and beekeeping.

The following are some of the untrue statements in Greek writings relating to bees, which were accepted and repeated by writers in Roman and later times, even up to the 1700s.

In Book V.21.553a, 553b, by Aristotle:

- With regard to the generation of bees different hypotheses are in vogue. Some affirm that bees neither copulate nor give birth to young, but that they fetch their young from the flower of the callyntrum, ... of the reed, ... of the olive.
- Now of these rulers there are two kinds: the better kind is red in colour, the inferior kind is black and variegated.
- Of bees there are various species. The best kind is a little round mottled insect; another is long, and resembles the anthrena; a third is black and flat-bellied, and is nick-named the 'robber'; a fourth kind is the drone ...
- Of the king bees there are, as has been stated, two kinds. In every hive there are more kings than one; and a hive goes to ruin if there be too few kings ...
- The bees first work at the honey comb, and then put the pupae in it: by the mouth, say those who hold the theory of their bringing them from elsewhere.
- The honeycomb is made from flowers, and the materials for the wax they gather from the resinous gum of trees, while honey is distilled from dew.

In Book V.22.554a, by Aristotle:

- Honey is what falls from the air. ... The honey, however, it [the bee] does not make, but merely gathers what is deposited out of the atmosphere.
- The bee carries wax ... round its legs.
- From the young of the king bee there is no intermediate stage, it is said, of the grub, but the bee comes at once.
- The bee lives for six years as a rule, as an exception for seven years.

The smaller number of errors in Book IX, written by another (unknown) author, included the following.

- Bees scramble up the stalks of flowers and rapidly gather the beeswax with their front legs (40.624a).
- In a high wind they [bees] carry a stone by way of ballast to steady them (40.624b).
- Before they [bees] drink [from a stream] they first disgorge their load ... [of honey] (40.626b).
- They all either fly to a distance to discharge their excrement [true] or make the discharge into one single comb (40.627a).

53

Bees and Beekeeping: History of Gender Roles

53.1 Introduction

In general, human gender roles in relation to bees and beekeeping conformed to gender roles in other activities. Chapters in Parts II to V of the book describe the harvesting of honey and wax from natural nests and traditional hives, and examples from these Chapters are used to illustrate gender roles at different periods and in different cultures. Section 53.5 refers to gender roles in more advanced beekeeping in technologically developed regions. Section 53.6 deals with the presumed gender and sex of the large ruler bee in the honey bee colony. These were regarded universally as masculine and male until the 1500s, after which the knowledge slowly spread that this bee was female.*

53.2 Gender roles in harvesting honey from natural nests

Honey bees

In many human hunter-gatherer societies, plant foods such as roots, leaves, seeds and berries were collected by women, and they formed the bulk of everyday diet. Men hunted farther afield for mammals, birds, fish, and insects including bees' nests. Among 175 hunter-gatherer cultures studied by anthropologists in Africa, Asia, America and Oceania, the women's daily gathering of food provided four-fifths of the total intake (Miles, 1988). The remaining one-fifth was obtained by hunting, but less frequently and less regularly; in 3% of the cultures studied, hunting was totally and invariably done by males, and in 97% it was exclusively dominated by them.

In the traditional division of work it seems likely that men usually collected honey, often when away on a hunting trip; a woman was generally less strong than a man and slightly smaller, so unable to reach as far, and honey bee nests were often approached by hazardous climbs on trees or rocks.

*Masculine and feminine are used here to denote gender, and male and female to denote sex.

It is interesting to look at the behaviour of chimpanzees getting honey from nests (Section 5.4). Both males and females have been observed climbing up to nests and getting honey, and some used tools to gain access to a nest and to extract honey from it. At one nest, the order of precedence among individuals extracting and eating the honey comb was male, then female, then juvenile. At another nest, one female was especially expert in devising appropriate tools and, while she used these in turn, four other individuals waited and then took what honey remained. A female chimpanzee with a baby clinging to her hair was able to climb trees, whereas a woman carrying a child would have difficulty in doing so.

Records of honey hunting show that women and children might keep a lookout for bees' nests, and that they were actively interested in the harvest from them; see Figure 7.1b. In the rain forests of Zaire, when the Ngandu hunted for nests containing honey, 'men carry axes from the homes for the work, even if it is a woman who actually finds the tree with a beehive' (Takeda, 1990). Nevertheless in unusual circumstances women have become honey hunters, for instance in Zambia (below).

Men away on a general hunting trip often consumed large quantities of honey they found, either on the spot or at their camp. This was true for instance of Mbuti in Zaire (Section 8.13), and of Kayapó in the Amazon basin who hunted stingless bees (Section 11.43). Honey taken home was distributed by the finder – as meat was distributed by the man who killed the animal – and then passed into the care of the women for use and storage.

Rock art provides a little evidence on gender roles in collecting honey during Mesolithic and Post-Mesolithic periods. A Mesolithic rock painting of honey collection in Spain (Figure 7.1a) shows a bees' nest and two people on a ladder. It has sometimes been said that the one at the nest may be a woman (e.g. Ehrenberg, 1989), but this figure shows none of the features listed by Pager (1971) as identifying either a man or a woman in (mostly African) rock art. However, in one rock painting in Zombepata cave in Zimbabwe (Figure 53.2a), the person at the nest

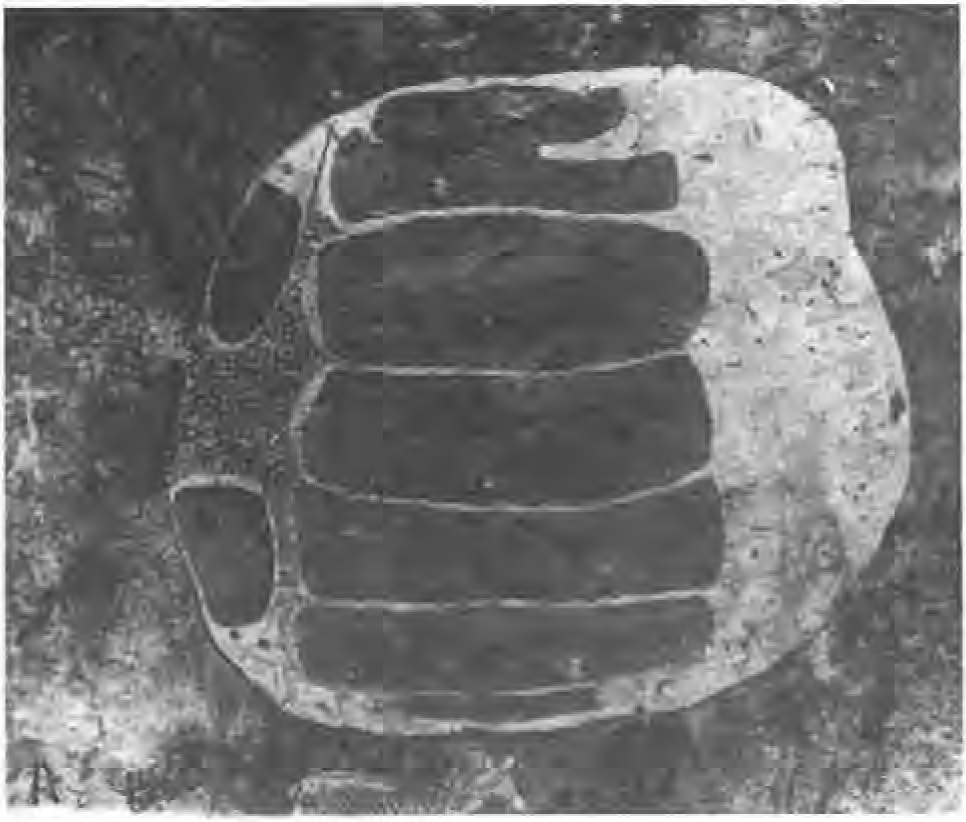


Figure 53.2a Rock painting showing a woman honey hunter (far left) at a bees' nest, Zombepata Cave, Zimbabwe (Register ZN-005, photo: H.C. Woodhouse).

entrance, carrying a long stick, can be identified as a woman by her breasts and steatopygous buttocks. In the 12 scenes in India which show honey-collection from *Apis dorsata* nests (see Table 10.2B), most of the people are men, but Mathpal (1984) referred to a few as women: in Figures 10.2c, 10.2a (at the top of the tree), and 10.2b (with the collecting bag). Mulder and Heri (1996) found that Malayu women as well as men might participate in harvesting from *A. dorsata* nests built on *tikung* in Kalimantan (Section 18.2).

In some of the honey-hunting societies recently studied in tropical Africa (Chapter 8), women were actually prohibited from collecting honey from honey bee nests, although among the Ngindo in Tanzania they might participate in the work in an emergency (Section 8.13). Sexual abstinence might be required of a man for several days before he went hunting. The Bassari in Senegal, who followed this custom, believed also that a husband would be wounded while he was away if his wife then had sexual relations with another man (Gessain & Kinzler, 1975).

In Sri Lanka, spirits of certain earlier Vedda women were associated with honey collected from *Apis dorsata* nests; one, Unapane Kiriamma, gave luck in getting honey and also made the bees build good comb. A piece of comb was left for her, with the invocation 'Eat, O Kiriamma!' If a man working at a nest was supported by a rope and this was cut, he would certainly die. A Vedda honey hunting song commemorated women whose husbands had been treacherously killed, probably in this way. On a happier note, parents might give a daughter's new husband a piece of land that contained *A. dorsata* nests. Customs of the Chenchu in northern India were somewhat similar to those of the Vedda. In Tamil Nadu, south India, among the Peechi-Keni people five generations ago (but not now), women as well as men climbed down a steep cliff to harvest *A. dorsata* honey. However, a husband and wife of the Kurumba look for nests together, and make an ownership mark for future harvesting by the man (Nath *et al.*, 1994).

Section 16.23 refers to statutes in Poland in 1347 relating to tree beekeeping (tending nests in trees in forest land): in these 'bee woods' men and women had equal rights in buying and selling. An area of land containing nests might be owned jointly by a husband and wife, and inherited by either a son or a daughter (Jankowska, 1989). It is not clear who worked at the nests in trees, or in hives, but no suggestion has been found elsewhere that tree beekeeping was done by women.

In almost every society men, women and children all ate honey. In tropical Africa, much of the honey from both nests and hives was made into honey beer, which in general only men were allowed to make or drink (Section 48.4). However, in Kasempa District in Zambia, Clauss (1992) met a widow beer brewer who had collected half a tonne of honey in the previous year, and six other women in the area were honey hunters; each was the head of her household. In southern Sudan custom varied from people to people. Only women of the Wau and Baï peoples brewed honey beer; among the Belanda-Bor either women or men could do it, but only women could distil honey beer to make *siku*, and such work provided the entire income of many single women (Brown, 1984).

Stingless bees

Among some African peoples, for instance the Adio in southern Sudan, women and girls as well as men collected honey from nests of stingless bees (Brown, 1984), but were not allowed to do so from nests or hives of honey bees.

Among the many peoples in South America, men collected the honey from nests of stingless bees and wasps, although most nests were not as high or as large as those of honey bees. Among north-western Gê (which include the Kayapó) in the Amazon basin, 'men seemed to have gathered nothing but honey', whereas women collected whatever they found (Steward, 1963). Exceptionally, in Colombia and Venezuela Yukpa women as well as men hunted for wasp nests, and collected from those that were not difficult of access. The Cavinia in Bolivia had a legend about a woman who died after her arm became stuck in a cavity when she was collecting honey from a nest of stingless bees. The Guaymí in the Caribbean lowland were said to give most of the stingless bee honey collected to the women and young babies (Steward, 1963).

In Australia the situation was somewhat different. Section 11.5 refers several times to recent records of women getting honey from stingless bees, and Figure 11.5b shows a man carrying a bag for collecting honey, and a woman. Flood (1995) found that women Aborigines did honey hunting and harvesting as much as men, on an opportunistic basis. Many nests were in termite mounds, or in trees that were small as a result of frequent bush fires and could be reached without climbing or destroying them. In parts of Australia too dry for stingless bees, honey ants were especially important, and women did most of the collection of replete ants from their underground nests (Section 13.4).

53.3 Gender roles in traditional beekeeping

53.31 The Ancient World

All known Ancient Egyptian representations of honey harvesting show men, not women. All Greek and Roman writers on beekeeping were men, and beekeepers were referred to as male. They were told to abstain from sexual relations for a specified period before handling hives – a day according to Columella (IX.14.3). Women were regarded as a potential danger to bees: 'If a menstruous woman do no more than touch a bee hive, all the bees will be gone and never more come to it again' (Pliny, VII.64).

The Babylonian *Talmud*, compiled in the early centuries AD, included rules about the buying and selling of hives of bees, using terms 'if a man sold', and 'if a man bought' (Section 21.1).

Women were among those who made alcoholic drinks in the Ancient World (Gayre, 1948), and this custom continued; Section 53.2 refers to women brewers in Zambia and southern Sudan.

53.32 Primitive agricultural societies

A study by Boserup (1970) showed that, in these societies in the tropics, the proportion of the work done by women was highest in Africa, followed by south-east Asia, Arab countries, and the Americas. However, this does not seem very relevant to beekeeping, because in tropical Africa traditional hives were sited in high trees to protect them from enemies, and as far as is known only men climbed the trees to attend to them.

In the 1980s, several peoples in southern Sudan who did not allow women to collect honey from bees' nests also forbad them to harvest it from hives (Brown, 1984), and this is likely to be an old custom. Bantu-speaking people of Kigezi in south-west Uganda discouraged women from approaching hives, and a menstruating woman who did so was punished by stoning. Also, if she ate freshly harvested honey, her menstrual period would be prolonged, and the beekeeper's honey yield reduced (Roberts, 1971). In Nigeria, traditional hives of all types sited in trees were operated by men but, in the centre and south, pots on the ground were also used as hives, and these were owned and harvested by women (Mutsaers, 1993). Bakiga women in Mulera farther south in Africa were not allowed to eat honey when they were menstruating (Seyffert, 1930), and in Sri Lanka the odour of a Vedda woman at this time was considered to make the bees troublesome.

In regions where the local bees stung little or not

Figure 53.3a Apiary in Flanders with four adults and a child, all well protected, by Jan van der Straat, c. 1580. Some are tanging a swarm to make it settle, and others are taking a settled swarm from the trunk of a tree.

at all, and colonies and hives were small, these were often kept in the shelter of house walls and sometimes tended by women; Figure 30.3b shows such hives of stingless bees in Costa Rica. Around 1990, among hill peoples in northern Vietnam, I saw that some woman took an active part in traditional beekeeping with *Apis cerana*.

Among adherents of certain religions, for instance Islam or Hindu, men managed outside affairs and women those within the household. In several mountain valleys of the upper Indus basin in Pakistan, I found in 1993 that Muslim women living in purdah might attend to the hives (of *Apis cerana*) which were embedded in the house wall. Honey combs were harvested from inside the house by removing the back hive closure and smoking the bees out through the flight entrance, but no bee management was practised. I was told by Khalid Khan, Peter Michel and others that this was (or had been) the custom in parts of Upper – but not Lower – Swat, the Kagan valley north of Attock, and the Murree Hills farther east, and also in the lower Indus basin in middle Punjab.

In Himachal Pradesh in India, Hindu women in Sirmour District also attended to *A. cerana* bees in wall hives (Roy, 1995). In 1996 I visited a Muslim woman in Galilee in northern Israel who kept traditional hives of *Apis mellifera syriaca* in the enclosed yard of her house.

*

Many bee specialists interested in giving aid to developing countries have stressed the benefits of beekeeping as an activity for women. I think that some knowledge of gender roles in the people's traditional beekeeping would be helpful when considering what type of beekeeping to promote as an activity for women.

53.33 Western Europe in mediaeval times and later, with examples from England

Among some European peoples converted to Christianity, women had a somewhat higher status and

were freer in their movements. Hildegarde (1098-1178) was Abbess of a community of nuns near Bingen on the Rhine in Franconia, and one of the books she wrote, *Physica*, contained a short chapter on bees which Armbruster translated into German in 1942. This mentioned a hive (*vasculo*), but said nothing about beekeeping. An illustration in a French herbal from the 1400s (Marchenay, 1979) shows a woman lifting up a log hive. The first use of the word 'skep' in English, according to the *Oxford English Dictionary*, is in a sentence from 1494 which seems to refer to a woman beekeeper: 'The same Kateryne shall have fre ysve [issue] to goo and come to hyr hive skeppys being w'in the Messe [messuage] and Yards.'

The 1523 *Boke of husbandrye*, by either John or Sir Anthony Fitzherbert, gave details of the work of the farmer and of his wife, but did not mention beekeeping. The 1568 edition contained only a recommendation to the 'husbandman' to kill drones. However, there are records of women beekeepers in the 1500s, after the Reformation of the Roman Church had started in western Europe. Figures 33.4c and 53.3a, from the 1580s, both show a Flemish woman taking part in an attempt to get a swarm to settle. Figure 53.3b, which is later,

Figure 53.3b Man cutting honey combs from a horizontal hive, and his woman helper, in front of an apiary of skeps (miniature from *Tacuinum sanitatus* (Albucassis, 1673) in Bibliothèque Nationale, Paris). Albacassis was born in Córdoba, Spain.

shows a woman standing ready to receive the honey combs a man is harvesting.

All the following English records are later than 1534 when King Henry VIII broke with the Roman Church. The 1580 edition of Thomas Tusser's *A hundreth good pointes of husbandrie* included the instructions:

20 (for September)	*23 (for December)*
Drive bees good conie,	Helpe bees, good conie
for wax and for honie.	with licour and honie.

In the late 1500s 'conie' was used as a term of endearment for women (*OED*). In John Levett's *The ordering of bees*, published in 1634 but written very soon after 1600 (Hartlib, 1655), women were regarded as the usual country beekeepers: 'The greatest use of this book will be for the unlearned and Country people, especially good women, who commonly in this Country take most care and regard of this kind of commodity ...'. William Lawson's *The country housewife's garden* (1618) dealt 'with the Husbandry of bees, published with secrets very necessary for every Housewife'. He set out his views on a countrywoman's responsibilities, for instance: 'I will not account her any of my good Housewives, that wanteth either Bees, or skilfulnesse about them.' Later, 'the chiefest help she can make her bees [is] a warm, dry house', and Figure 53.3c shows such a structure. After many other instructions, the Chapter ended: 'Bees thus used, if you have but forty

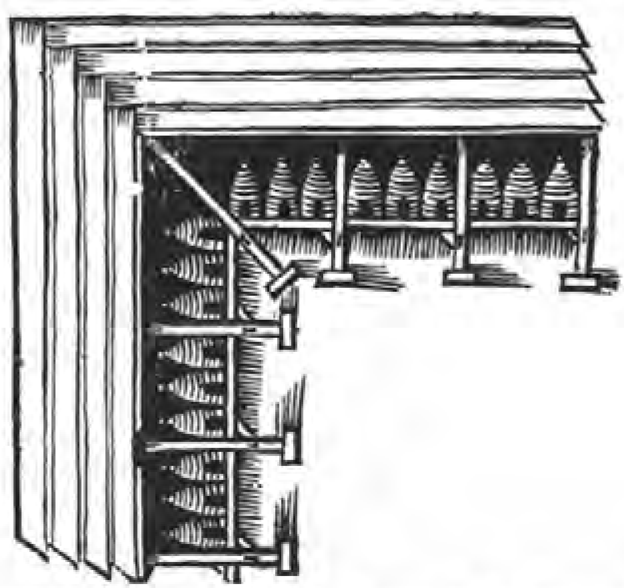


Figure 53.3c Bee shelter with 18 skeps, for the housewife (Lawson, 1618). 'You must have an house made along a sure dry wall in your Garden, neere, or in your Orchard: for Bees love Flowers and Wood with their hearts.'

Figure 53.3d Frontispiece of *Dictionarium domesticum* (Bailey, 1736). See text.

stocks, shall yeeld you more commodity clearely than forty acres of good ground. And thus much may suffice, to make good Housewives love and have good Gardens and Bees.' According to Aubrey (c. 1690), Charles Butler gave to his daughter when she was born: 'certain stocks of bees, the product of which when she came to be married, was 400 *li* [£400] portion'; there is no evidence that she herself looked after her bees.

John Evelyn referred to 'the Housewife cruelly destroying [bees] to take their Honey' in *Elysium Britannicum* (c. 1655). F.B.'s *The office of the good housewife* (1672) included in the subtitle 'the manner of keeping and governing silk-worms and honey-bees: both very delightsome and profitable'. A few years later Worlidge (1676) said that bees were 'of any Creatures whatsoever the most easily managed and improved ... as many poor and ignorant Country Housewifes can tell you'.

English probate inventories and other unpublished documents from the 1600s occasionally mention hives owned by women, and at least twice to hives stolen by women. Other references to women beekeepers in Britain include the following (Robertson, 1988). In 1690 Mrs Margaret Clifton, of Timberland Thorpe near Lincoln, won a premium of 7 guineas from the Society of Arts for increasing her stocks of bees. In 1698 and 1699 payments were made in Scotland 'to bessie haddoway in coldham for 2 new beeskeps, 16 shillings', and 'to Wm youngs wife in Costorphin to take care of the hyve of bees flew to Coast [a swarm that flew towards the coast?], 3s. 6d.'

The frontispiece of Nathaniel Bailey's 1736 *Dictionarium domesticum* (Figure 53.3d) shows a farmer's wife 'furnishing the house with the most common necessities of life'. The skeps – which the book said should be 'made of good wheat straw bound with bramble' – were outside the door. Keys (1780) referred to 'the farmers dames' extracting honey from combs. Wives of many beekeepers continued to take part in this work, even if they did not share in the beekeeping. But the custom for some English countrywomen to do the beekeeping continued into the 1800s, when Mary Mitford's *Our village* (1824-1832) referred to the 'cows, poultry, bees and flowers' of a farmer's wife as her pets.

53.4 Gender roles in Europe, 1700s-1800s

From the 1700s, a certain number of wealthy women had a very different life from farmers' wives, and they were also thought to have delicate sensibilities. Several writers gave instructions to enable such ladies to watch bees in safety. Figure 53.4a is taken from a broadsheet issued in 1788 by Richard Hoy from his honey warehouse in Piccadilly, London. Hoy recommended his 'Box & Glass Bee-hives contrived so as Ladies may have them on their dressing Tables without the least danger of being stung'. The text makes it clear that a gardener did any necessary handling of the hive or bees.

On a more practical level, in the 1700s and 1800s a few women published household books related in some way to bees. The earliest was Hannah Wolley's *The queen-like closet* (1670) which gave recipes for preserves, etc., including some for making metheglin from honey and for wax work and colouring. Shirley Hibberd (1856) wrote about beekeeping as a suitable

Figure 53.4a Lady's hive, with large and small glass bell jars and a small observation window (Hoy, 1788). The hive is on her dressing table, and the bees flying are presumably outside.

pursuit for ladies interested in 'sweets, cordials, perfumes and confections', who could surely spare an hour a day from their unproductive pastimes to devote to bees, all the more since 'the hive is a feminine empire'. Of 420 books relating to bees published in Britain and Ireland before 1900 (IBRA, 1979), twenty were by women.

The first scientific and technical advances by women were made during this period. Catherine Elisabeth Vicat (née Curtat) in Switzerland took an active part in the advancement of rational hives, and Figure 40.4b shows a hive she devised. From 1760 onwards, 64 reports and notes on her experiments and observations appeared in publications of the Economic Association of Bern (Maibach, 1941). She joined many Beekeeping Associations, and was made an Honorary Member of Learned Societies in Biel in Switzerland, Berlin and Dublin (Sooder, 1952). Also in Switzerland, two women helped Huber with his scientific work on bees: his wife, and Mlle Jurine to whom he paid tribute in Appendix 2 of his 1841 book. She dissected out the wax glands of workers, and showed that they were the source of the wax secreted.

A notable beekeeper in Scotland in the 1800s was Miss Clementine Stirling Graham, the last member of the family of Claverhouse, Viscount Dundee. She kept bees in skeps on the family estate at Duntrune, which her gardener William Spalding tended under her instruction and observation. She promoted the practice of preserving the bees when taking their honey, and taught it to her cottagers. For Spalding's benefit she made an English translation of a book by Gélieu, *Le conservateur des abeilles* (Switzerland, 1816), which was published in Edinburgh – anonymously in 1829 and under her name in 1876 when she was 96. John Beveridge visited Miss Graham in 1875, and later described her enthusiastic adoption of Woodbury's movable-frame hive, probably in the late 1860s (see Beveridge, 1972/73).

53.5 Gender roles in modern beekeeping

In Europe and North America, the creation of Beekeepers' Associations and beekeeping journals between 1850 and 1900 (Chapter 42) increased women's effective participation in beekeeping. Women as well as men attended Association meetings, and by then were sufficiently educated to read the journals. They thus acquired knowledge on the new beekeeping directly, instead of being dependent on what their husbands told them. Beveridge (1941) described conditions in Scotland in the 1890s. He had known only two women who were beekeepers before the Beekeepers' Associations existed; some others had attended to the hives of their menfolk during the day, but if one of these was asked why she did this or that, she would say: 'My man [husband] told me to do it and I did it'. When the Associations were formed, such women got hives of their own, and were able to keep the profits from their bees.

For a long time, however, most men were unwilling to recognize that women might be able to manage bees, and most women remained a man's compliant helper. In Japan, Figure 53.5a illustrates this, although Figure 29.3b shows both men and women harvesting honey combs from box hives in 1859. Carl Rehs in Prussia, who lived from 1869 to 1947, said about one type of hive: 'It is simple, cheap and prof-

Figure 53.5a Man taking a swarm, with woman helper, near a modern hive (*Hachimitsu-ichiran*, Japan, 1872).

itable, and can be managed successfully by everyone, also by women' (Jacoby, 1964).

In the USA, most women who did any bee work assisted their husbands, but in the 1880s Mrs L. Harrison of Illinois was herself a large-scale beekeeper, and in 1882 she published details of her bee dress (Figure 53.5b). In 1879 Moses Quinby of New York State had written about women's protective clothing, because 'women are becoming more and more interested in practical bee-keeping'. He believed that long clinging skirts were quite out of place in the apiary, and that 'every woman who wishes to work among the bees should wear a dress suitably short ... drawers should be made of the same material, ... tolerably wide, gathered on a band at the bottom, and buttoned tight about the ankle'.

After the First World War (1914-18) it was somewhat more usual for women to keep bees, although most were less well constituted for heavy lifting. Very few became large-scale commercial beekeepers. In many countries, it was still a common practice for a man to do the beekeeping, and his wife at home to do much of the honey extracting, handling, bottling and selling.

The readiness with which tropical African bees are alerted to sting made them unsuitable for keeping near the house, or on nearby land where the women

Figure 53.5b 'Bee-dress' for women (Harrison, 1882). 'The hat is made of green wire gauze ... the top of pasteboard, and the bottom of calico.'

cultivated food crops for family consumption. In South and Central America, European bees could be kept fairly near the house, but not the Africanized bees which replaced them after 1956. In Vietnam and many other parts of Asia, modern beekeeping with introduced European *A. mellifera* involved migrating the hives, and was done almost entirely by men, but women might keep *Apis cerana* in modern hives near the house.

53.6 Gender and sex of the ruler of a human and of a bee community

53.61 The King-bee

In early days, what people saw of the behaviour of the large ruler bee in a hive was similar to that of a human ruler; many people linked such behaviour with the masculine gender, and assumed that the ruler was biologically male. Aristotle referred to the ruler bees as kings (Section 52.10). Passages written in the Ancient World, and during and after the Middle Ages, described the colony as a male society*

*Gousiaris and Deliyannis (1998) studied early Greek texts which praised the large leader bee in the hive for its outstanding leadership abilities and wisdom. Some authors, including Hesiod, Semonides, Pappus, and Arrian quoting Epictetus, praised the bee's feminine gender characteristics. So did Xenophon in *Oeconomicus* 7.32-33, but in *Institutio Cyri* 5.1.24 he praised its masculine gender characteristics, using almost identical terms. In either case, all the other bees are subject to their leader and do not want to be separated from him/her. These authors conclude that praising bees was a common rhetorical device of classical Greek writers, but that they did not know or care whether the large bee was male or female.

whose members carried out masculine occupations, under the authority of their omnipotent but benevolent king.

In England the 1568, 1593 and 1608 editions of Thomas Hill's treatise on bees all included a chapter on 'the marvellous government of the King of Bees, and of the obedience which they use to him'. Lawson (1618) referred to the Master Bee, and Moses Rusden (1679) to the King-Bee. Rusden dedicated his book to King Charles II who had appointed him the King's Bee Master, and his frontispiece shows the King-Bee wearing a crown. He wrote:

> The King is a fair and stately Bee, having a majestic gate and aspect ... commands and orders all ... His Government is absolute, because his orders are never disputed but obeyed, as well in swarming, and executing their Drones, and young Princes, as in watching, and working.

53.62 The mother-bee – or mother-colony?

Section 54.42 (*The Paschal candle*) quotes a passage from the late 300s in which St Ambrose invoked the 'blessed and marvellous mother bee'. Somewhat similar invocations in a few swarm charms during the 800s/900s have sometimes been interpreted as recognizing that the 'ruler' bee was female. Swarm charms were short verse or prose passages used by a beekeeper to persuade an airborne swarm (the bees and/or its 'ruler') not to fly away but to settle. Fife (1939) cited 97 of them from western Europe dating from the 800s onwards, in three of which the invocation included a female term. One now in the Austrian National library included the lines:

> *Apis modicula*
> *mater matricula*
>
> Humble little bee
> little womb-mother

Another from Switzerland started:

> *Adjuro te mater aviorum* [*sic*]
> *per deum regam coelorum ...*
> *ut non te in altum levere*
> *ibi habeo bona vase parata*
>
> I bid thee, mother of bees
> by God, King of heaven ...
> not to rise up on high.
> I have prepared thee a good hive.

The third, Anglo-Saxon and probably pre-Christian, included the word *sizewif*, which has been variously translated: victory women (Ransome, 1937; Holton, 1993); my ladies (Fife, 1939); victor dames (Fraser, 1958).

Laws in North Wales written in 1200s (Section 27.52) used the term *modrydaf*, which Owen (1841) construed as 'mother of the bees', i.e. queen bee. Crane and Walker (1984/85) suggested that the term *modry[by]daf* was more probably used to mean colony-mother or mother-colony. Other terms in early sources were discussed by Charles-Edwards and Kelly (1983), including Old English *beomoder* in the 900s.

I have great difficulty in accepting that, in periods when the ruler bee was generally referred to as masculine, writers who used feminine terms (for instance St Ambrose, Section 54.42, *The Paschal candle*) actually knew that the ruler was female and the mother of all the other bees – laying the eggs from which these bees developed. On the other hand the term mother-colony for one which had produced a swarm seems appropriate; the swarm came out of the 'womb' of the hive or nest-hole, as a newborn human or other mammal came out of the womb of the female who was thereafter designated *mother*. Or perhaps the occasional early mediaeval use of a term such as 'bee-mother' had no greater significance than that of, say, mother Earth or mother Nature. I wrote earlier (1980a):

> As man became interested in bees in their own right, they seemed most mysterious and therefore magical creatures. Singly the bees flew out and home again; more astonishingly, at a certain season they flew out as a swarm that seemed to have a mind of its own. They showed miraculous fertility: after the end of a dearth period when growth had been halted, a handful of bees would increase their number in a short time to a swirling mass, yet their method of generation could not be seen or understood, as could that of mammals and birds. ... Moreover their dwelling on earth was a dark cavity which some scholars regard as a symbol of the womb where the human soul itself was generated.

53.63 The Queen-bee

Charles Butler in England, who was probably born in 1571, called his 1609 beekeeping book *The feminine monarchie*. Queen Elizabeth's reign lasted from 1558 until 1603, so she had been his Sovereign for almost all his life. Butler referred to the ruler of the

bees variously as Queen, Sovereign, stately Prince, and Governour, and his Chapter 1 includes the statement:

> And al this under the government of one Monarch, of whom above al things they have principal care & respect, loving, reverencing, and obeying her in al things.... (§6)

His short passage about the reproduction of bees was taken from the Ancient writers Aristotle, Virgil and St Ambrose:

> Their [the workers'] chastitie is to be admired. ... They ingender not as other living creatures: only they suffer their drones among them for a season, by whose masculine virtue they strangelie conceive and breed for the preservation of their sweet kind. (§51)

Butler gave the following reason for choosing the title of his book. Aristotle, who was uncertain of the ruler bee's sex, 'every where calleth their governour *Rex* [King]'; Butler now sought the Reader's leave 'to straine the ordinarie signification of the word *Rex*, and ... to translate it *Queene*, sith [since] the males heere [among bees] beare no sway at all, this being an *Amazonian* or feminine kingdome'. Perhaps Butler had a mental picture of the (Virgin) Queen of England – much as Rusden, who wrote in 1679 when a King was on the English throne, thought in terms of his King and patron.

Butler dedicated his third edition (1634) to Queen Henrietta Maria, wife of King Charles I. Samuel Hartlib's *The reformed common-wealth of bees* was published in 1655 during Oliver Cromwell's Protectorate, but he continued the same theme.

> This is a feminine Monarchie, the females governe ... But see this royall Queen of Bees, how qualified; she is faire, comely, loving, harmlesse, gentle, peaceable, yea a vigilant Queen, a royall emblem of government.

In 1712 Joseph Warder published *The true Amazons, or, The monarchy of bees*, dedicating it to Anne, then Queen regnant. The book said that workers laid all the eggs, and 'the *Queen-Bee* Governs with Clemency and Sweetness, so doth Your Majesty; she is Obey'd and Defended, out of Choice and Inclination by her Subjects, so is Your Majesty'.

Before the next bee book was dedicated to a Queen, it had become known in England that the ruler of the hive was female, and mother of all other bees in it (Section 52.61). *A treatise on the management of bees* ... by Thomas Wildman (1768) referred to the books by Thorley (1744) and Swammerdam (1758); his second edition in 1770 was dedicated to Queen Charlotte, wife of King George III, in terms very similar to those quoted earlier, although he was now able to refer to the queen as the mother of her bees. The book 'treated of bees ... whose supreme magistrate is a Queen, who is in every respect the mother of her people, and whose gratitude, homage and affection to her is equally sincere and lasting'. In 1832 Thomas Nutt's *Humanity to honey bees*, dedicated to 'Her Most Gracious Majesty, Queen Adelaide', wife of King William IV, referred to the 'true allegiance on the part of the subject-Bees to their Sovereign'. Finally, in 1838 the second edition of Edward Bevan's 1827 *The honey bee* was dedicated to Victoria, Queen regnant, who had acceded in 1837. He included the sentence: 'The queen of every bee-community has been destined to fill her high station, from a very early age (not always from her birth)' – i.e. like Queen Victoria.

The idea of a bee community as a model for a human community had been put forward from Ancient times in various countries, and Section 54.6 gives examples from France and England in the 1500s. But it seems to have been a special characteristic of English writers between 1600 and 1850 to regard the bees' devotion to the feminine ruler of their colony as a proper model for human devotion to the Queen of their country.

54

Bees and Bee Products in World Religions

54.1 Prehistoric religions

A number of peoples in prehistoric times believed in the sacredness of honey, and of bees. Although they did not leave written texts, some of their beliefs have survived until recently, and we can still see some of their art. In her study of the myths, legends and cult images in the civilization of Old Europe between 7000 and 3500 BC, Gimbutas (1974) found that bees took second place only to snakes among sacred objects. Both creatures lived in a dark hole, both were 'venomous', and both issued forth miraculously from the hole (the bees as a swarm) at a certain season of the year. But whereas snakes might be symbols of either good or evil, bees were almost always regarded as beneficent.

Chapter 6 explored man's first interactions with bees, and Chapters 7 to 13 gave examples of surviving beliefs of hunter-gatherers, their rituals for propitiating the spirit of the rocks or trees in which bees' nests were found, and purification rituals which had to be undertaken before a honey hunter set out. In different prehistoric religions people believed that spirits or deities lived in animals and plants, and also in inanimate things such as rocks or storms; Shinto in Japan was a religion which grew out of such beliefs. In some of the religions it was believed that only a shaman, witch doctor or priest had direct contact with the spirits or gods; among certain peoples, for instance in Sumatra (Section 15.23), only a shaman could do the actual collection of honey from a bees' nest. According to *Ifa*, the ancient literature of Yoruba people in Nigeria, many thousands of years ago God sent the honey bee to the earth at Ile-Igbon, whence it spread to other parts of the world (Komolafe, 1995).

Figure 6.3b shows a goddess in the shape of a bee depicted between 4000 and 3500 BC. Rock paintings of honey-getting from bees' nests were made earlier, in Mesolithic times, and Chapters 6-8 and 10 show examples. In Southern Africa, San people made many rock paintings of bees and their nests (Section 8.11) and often superimposed one painting on an earlier one, but they never overpainted subjects that had a magico-religious significance. Pager (1974) studied several thousand paintings in Ndedema Gorge, and found that bees and allied subjects were overpainted less than any subject except the eland and various mythical creatures. This strongly suggests that bees and their honey were sacred to the San.

Certain peoples in South America had extraordinary and intimate relationships with the stingless bees that lived in their area, and what was harvested from them. This was true, for instance, of the Kayapó in the Amazon jungle of Brazil, the Guayaki in Paraguay, and the Mataco in the Gran Chaco of Bolivia (Sections 11.43 and 17.22). Religions of these peoples involved bees and provided both positive guidance and taboos for interactions with the bees.

54.2 Important world religions

Religion is sometimes defined as human recognition of superhuman power which controls the destiny of man and is entitled to his obedience. Table 54.2A lists some important world religions, and indicates whether honey or beeswax – or the bee – was acceptable as food, used as an offering, or regarded as sacred.

Polytheistic religions developed first, for instance among Sumerians, Ancient Egyptians and Hindus. Monotheistic religions – notably Judaism, Christianity and Islam – started later, as did the earliest important non-theistic religions named after their founder or most revered teacher: Zarathustra in Persia (Greek Zoroaster), and Buddha in northern India.

In general, the adherents of a religion were required to believe in its tenets and any written scriptures, and to worship the controlling power. In many religions bees, honey and beeswax became rich sources of symbolism which helped both illiterate and literate people in their worship, and in their understanding of certain abstract concepts. In religions which required offerings as acts of devotion or worship, honey was commonly sacrificed from early times (Section 54.32).

Table 54.2A

How honey, beeswax and bees were regarded in some world religions

O = used as an offering; S = sacred during at least one phase of the religion;
F = eaten as food or medicine; a question mark indicates that the entry did not apply to all adherents.

From approx.	*Region*	*Religion or civilization*	*Honey*			*Beeswax*	*Adult bees*	*Bee brood*
			O	S	F	S	S	F
	worldwide	prehistoric religions	O?	S	F		S	F
–3000								
	Sumer	many gods	O	S	F			
	Dynastic Egypt	many gods	O	S	F		S	
–2500								
	India/Indus basin	based on Aryan *Veda* scriptures (later Hinduism)	O	S	F		S	
	Middle East	Ancient Israel, later Judaism	O		F			no
–1000								
	Persia	Zoroastrianism		S	F	S	S	no
	India	Buddhism		S	F			no
	India	Jainism		none		no	no	no
	Greece/Crete	many gods	O		F		S	
	Rome	many gods	O		F			
	China	Confucianism	O		F			F?
	China	Taoism			F			F?
	Japan	Shinto			F			F
+30								
	Palestine	Christianity		S	F	S		
+250								
	Mesoamerica	Maya	O		F		S (bee gods)	
+500								
	Arabia	Islam			F			no
+1000								
	India, Punjab area	Sikhism			F			

Sacred texts of all or most early religions were based on oral forms which had existed at a time when people obtained honey and beeswax only from bees' natural nests. The initial beliefs were necessarily related to knowledge at the time, and some changed little thereafter. In religions established when people used hives and were more familiar with bees, the bee itself became more important as a symbol. The bee used in hives had a special place of honour in Islam, and among the Maya in Mesoamerica and, much later, the Mormons.

54.3 Honey and honey-based drinks in religion

54.31 A heavenly or divine origin of honey

The idea that honey had its origin in the heavens was widespread among early peoples (Ransome, 1937), and descriptions by writers in Ancient Greece and Rome may well have represented much earlier beliefs. According to Aristotle in the 300s BC, 'honey ... falls from the air, principally at the rising of the stars, and when the rainbow rests upon the earth' (*Historia animalium* V.22.554a). Pliny the Elder (AD 23-79) questioned: 'whether it is that this liquid is the sweet of the heavens, or whether a saliva emanating from the stars, or a juice exuding from the air while purifying itself' (*Naturalis Historia* XI.12.30).

The belief that honey fell from heaven probably contributed to its status as a sacred substance in pre-religious beliefs and in many religions (Table 54.2A). As late as 1609 the Reverend Charles Butler in England wrote 'The greatest plenty of purest nectar cometh from above; which Almighty God doth miraculously distil out of the air ... which thence doth descend into the earth in a dew or small drizzling rain.' (The fact that honey had its origin in the flowers was not understood until the late 1700s, Section 52.91.) A further apparently miraculous property of honey was that, mixed with water and left for a few

days (Section 48.1), it was transformed into a liquid which endowed the consumer with an apparently magical euphoria and eloquence.

54.32 Honey as an offering

In the Ancient World many peoples used honey as a ritual offering to establish communion with their god or gods, and honey may well have been one of the earliest non-animal sacrifices. Such honey, like sacrificed animals, might subsequently be eaten by priests or certain other classes of people.

Offerings of honey were often linked with those of milk, butter, ghee, oil, or incense. They were mentioned in one of the earliest known records written on clay cylinders, made in Sumer where Gudea ruled Lagash between the Euphrates and Tigris. The text described Gudea's construction of a new temple for the god Ningirsu about 2450 BC, and stated that he made offerings of honey and butter when the foundations were laid, and offered honey and other foods when the image of Ningirsu was finally put in place. Other Sumerian inscriptions show that honey was already a customary offering by Gudea's time. A somewhat later record reads: 'Bursin, King of Ur, King of the four regions of the world, erects a house of honey, of butter, and of wine at the place of his sacrifices' to the great god En-lil (Ransome, 1937).

In Ancient Egypt, much honey was sacrificed in religious ceremonies, and it was fed to sacred animals. During the 18th to 20th Dynasties (1567-1085 BC) in the New Kingdom, large quantities were offered to Osiris the god of fertility at the temples of Koptos and Akhrain. Breasted's *Ancient records of Egypt* (1962) lists official entries for such offerings from the 18th to 26th Dynasties, and honey is mentioned in 21 of the entries for offerings made by Ramesses III (1198-1166 BC). Four read as follows.

- Among the King's gifts to Ptah were 1046 jars of white incense, honey, oil, fat, butter (§344).
- Among offerings to the Nile god (listed immediately after 2968 kilts of southern linen) were 66 *hin* of honey for cakes, 164 jars of honey, 3280 jars of honey, also 250 *hin* of white fat for cakes (§350). [Honey cakes are referred to in Section 47.31.]
- Among the King's gifts to the gods were 567 jars of honey (§376).
- The total of the King's gifts to all gods included 331,702 jars and measures of incense, honey, oil (§390).

An Egyptian tomb painting from about 1450 BC (Figure 54.3a) shows a dish probably containing honey combs being offered to the Pharaoh, who was regarded as a god-king.

Israelites presented the first harvest of their produce – including honey – to their God, for the use of His priests. For instance in Jerusalem at the time of Hezekiah (late 700s BC), 'they gave generously from the first fruits of their corn and new wine, oil and honey, all the produce of their land; they brought a full tithe of everything' (II Chronicles 31.5, NEB). Honey had, however, been forbidden as a burnt offering around 1200 BC: 'You shall not burn any leaven or any honey as a food-offering to the Lord.' (Leviticus 2.11, NEB).

Earlier, honey was offered to at least two gods in Minoan Crete (Section 22.21). In Ancient Greece animals and also honey were sacrificed to many gods. In the *Iliad*, Homer (850-800 BC) referred twice to honey offerings. When Patroclus had been killed after defeating the Trojans, Achilles 'set therein [in the bier] two-handled jars of honey and oil, leaning them against the bier'. Then he sprinkled honey on the grave as an offering to gods of the underworld. In the *Odyssey*, Circe advised Ulysses that when he entered Hades he should sprinkle the shadows of the dead with honey, milk and wine. In the 700s BC, Hesiod's grave in Locris was deluged with honey by Zarathustra and pious shepherds. Greeks sacrificed honey especially to gods concerned with the productiveness of nature, for instance Artemis, Persephone, Aphrodite, Dionysus, Apollo and Pluto. Ransome (1937) devoted a chapter to honey in Greek religious rites.

In *The Persians* (472 BC), Aeschylus described offerings made by Queen Atossa to her dead husband Darius I.

> I return, and bear
> Libations soothing to the father's shade
> In the son's cause; delicious milk, that foams
> White from the sacred heifer; liquid honey,
> Extract of flowers.

Around 400 BC, Sophocles listed in *Polydos* the offerings favoured by the gods: wool, grapes, fruits, grain, 'oil of olive, and fair curious combs of wax, compacted by the yellow bee'.

In Rome, Varro (III.16.5) referred to honey as the sweetest substance of all, 'acceptable to gods and man alike', and to honey comb as placed on the altar. According to Virgil, the dog Cerberus which guarded the entrance to Hades was propitiated with 'a morsel drowsy with honey and drugged meal' (*Aeneid* VI.417). Later, Lucian recounted in *Charon* that when Hermes was asked why men dug a trench round a grave and poured honey and wine into it, he

Figure 54.3a Wall painting in tomb 101 showing an offering to Pharaoh, West Bank, Luxor, Upper Egypt, c. 1450 BC (photo: The Egyptian Museum). The dish may well contain honey combs, with two bees feeding on them.

replied: 'people believe that the dead are summoned up from below to the feast, and that they flutter round the smoke and drink the honey draught from the trench' (Ransome, 1937).

Section 54.5 refers to the offering of honey by Maya beekeepers in Mesoamerica to their bee gods.

54.33 Honey as a sacred substance

In some religions (Table 54.2A) honey was sacred, dedicated or devoted to a god or to some religious purpose, and it appears repeatedly in the earliest important religious text, the *Rig-Veda*. Some time about 1750 BC there was a great influx of Aryan people from central Asia through the Hindu Kush region into parts of the Indus and Ganges valleys, and the *Rig-Veda* was the first of their sacred books, accumulated over centuries – probably both before and after the migration. Around 1000 BC these were collected together; the Sanskrit text consisted of hymns to Aryan gods, to be performed while sacrifices were made to them. Words for 'bee' occur rather

infrequently (Mullick, 1944), but the word *mádhu*, used for both honey and mead, occurs some 300 times in the *Rig-Veda*, and thousands of times in the four *Veda* and their Commentaries; the following are a few examples.

Let there be *mádhu* inside and outside of me
Let me talk as sweet as *mádhu*
And let my whole character be as sweet as *mádhu*.
(*Atharva-Veda* I.34)

In the wide-striding Vishnu's highest footstep,
There is a spring of *mádhu*.
(*Rig-Veda* I.154.4-6)

Anoint me with the *mádhu* of the bee,
That I may speak forceful speech among men.
(*Rig-Veda* III.61.19)

The *Veda* are also referred to in Sections 47.21, 48.21 and 52.12.

Texts of many Ancient religions and civilizations linked milk and honey together, and both were 'sacred nectars' in Hindu and Buddhist traditions. Honey would have been obtainable from nests of bees before domesticated animals produced milk, from which curd or ghee was produced. Bread and wine came later still, from settled farming in Neolithic times.

In the Hindu Kingdom of Nepal, I was told in 1992 that five sacred 'nectars' were recognized: cow's milk, curd, ghee or butter from the milk, honey, and sugar from sugar cane. At a Hindu ceremony in a house, I saw the five nectars being mixed together; then a little was poured into the cupped hands of each person, who drank it. In some regions a sacred nectar had to be given freely when needed for a religious ceremony, and selling it was prohibited. During the same year I saw a mixture of sacred nectars distributed in a Hindu temple attended by people of Indian origin in Trinidad. Buddhists in Nepal recognized three sacred nectars – milk, honey and water – which they drank similarly.

Up to about AD 600 there were references to milk and honey as part of the Christian Eucharist. The earliest, by Clement of Alexandria (*c.* 150 to *c.* 215), compared milk and honey, as the food immediately after spiritual rebirth, with milk as the food after earthly birth. In the Roman Church from the 300s, milk and honey were taken after bread and wine (the consecrated elements of the Eucharist) as symbols of the promised land and of 'the union of the spiritual and human nature in Jesus Christ'. St Gregory, who was Pope from 590 to 604, wrote: 'When the grace of the Holy Spirit bathes us, it fills us with honey and butter equally. Honey falls from above, butter is drawn from the milk of animals.' During the early centuries of the Christian Church, milk and honey were given to neophytes immediately after baptism, to symbolize the promised land, and this was still the practice of the Coptic (Egyptian) and Ethiopian Churches in 1912. In the *Regulations of the Egyptian Church*, after the congregation had taken communion with bread and wine: 'then they communicate with the milk and honey as a foretaste of the coming time and the sweetness of the treasures therein.' Fife (1939) discussed these and other texts at length, and Galton (1971) referred to ritual uses of foods made with honey in the Russian Orthodox Church.

54.34 Honey as a food: heavenly, earthly, or proscribed

In the Hebrew scriptures the land promised to the Israelites in the wilderness was often described as 'flowing with milk and honey'. The heavenly paradise promised to Muslims contained rivers of milk and rivers of honey, and the paradise of the Celts in northern Europe had rivers of mead to drink as well as a stream of honey. And in the Norse paradise Valhalla, souls of slain warriors feasted and drank mead (Jones, 1968). In Southern Africa, San people believed that after death 'they will find great feastings on locusts and honey' (Stow, 1905).

The custom of giving honey to a new-born child was very widespread. In Hindu mythology Manu was the forefather of the human race; the laws of Manu ordered a male child to be fed honey and butter, while his father said: 'I give thee this honey food so that the gods may protect thee, and that thou mayst live a hundred autumns in this world' (Ransome, 1937). In India today honey is still often the first food offered to infants. According to the Hebrew scriptures, King Solomon (900s BC) exhorted his son: 'Eat honey, my son, for it is good, and the honey comb so sweet upon the tongue' (Proverbs 24.13, NEB). Figure 54.3b is reproduced from part of an image in a temple in Chiangmai in the north of Thailand, made before 1800. It shows an unusual scene: a monkey giving Buddha a honey comb, probably from *Apis florea*. Buddha is said to have eaten the comb, but only after removing some eggs he found in it (Burlingame, 1921).

Passages in the Jerusalem *Talmud* dated to the first few centuries AD show that Rabbis had some difficulty in deciding whether or not honey was a permissible food. In *Bekhorot* 7b, some authorities believed that 'the Divine Law expressly permitted

honey', but the translator added a note: 'although it may come from the body of the bee itself, and no reason is given for this.' Bees themselves were unclean; however, 'an unclean fowl that swarms you must not eat, but you may eat what an unclean fowl casts forth from its body. And what is this? This is bees' honey.' Also: 'Why did [the Sages] say that honey from bees is permitted? Because the bees store it up in their bodies but do not drain it from their bodies.' Honey is still eaten as part of certain Jewish ritual meals.

The Christian Church certainly approved of eating honey. In the Greek Orthodox Church honey was allowed as a food even during fasts; during the 1100s honey was a basic part of the monastic diet on Mount Athos in Khalkidiki, where hives are recorded from 1025 onwards (Nikiti, 1996).

Islam held honey in high esteem, and had explanations to show that honey could be eaten, although it came from bees which were regarded as unclean. Sura 16 of the *Koran*, the sacred book of Islam, was entitled *The bee* and said in verse 69: 'There cometh forth from their bellies a drink diverse of hues wherein is healing for mankind.' The consumption of fermented honey was, however, prohibited; see Section 48.2.

Jains were forbidden by their religion to eat honey because it would be contaminated from dead bees – or (MacClancy, 1992) because 'in the heat it might ferment and so intoxicate those who consume it'. Jains were prohibited from drinking alcohol and from eating any meat, including bees or bee brood (Grewal, 1996).

The end of Section 51.6 refers to religious prohibitions on eating bees.

In Mesoamerica the Maya drank *balche* to bring them into closer communion with their gods, including bee gods (Figures 30.2d and 54.5c). They made *balche* by fermenting honey and water with an extract from the *balche* tree; Bishop Diego de Landa's 1566 comments are quoted in Section 48.5.

54.4 Beeswax in religion

Beeswax itself was much less used as an offering than honey. For instance among the many records of offerings of honey in Egypt between 2500 and 500 BC (Section 54.32), I found only one for beeswax: 'also 3100 *deben* of wax' during the reign of Ramesses III. Beeswax was widely used for making devotional cult objects, and objects for destructive magic (Section 49.31), but Jains were forbidden to use it, because its production involved killing bees (Grewal, 1996).

Figure 54.3b A honey comb being given to Buddha by a monkey (photo: S. Wongsiri). See text.

54.41 Votive offerings

A votive offering or *ex voto* was made in pursuance or fulfilment of a vow, often as a thanksgiving for a favour granted. Votives were offered in Ancient Egypt, Greece and Rome, and especially by European Christians in and after the Middle Ages. Beeswax was a common medium for votives offered by poorer people; it could be moulded or cast to produce a very realistic model of a part of the body that had been cured, and thousands of such models can be seen in museums and Roman Catholic churches: arms and legs, and many internal organs as well. Hansmann and Hansmann (1959) described and illustrated the collection of votive offerings in a museum at Rosenheim in Germany. Section 46.81 refers to a much larger offering modelled in beeswax in 1278.

54.42 Beeswax candles in the Christian Church

Beeswax had its greatest religious importance in the Christian Church, where it was the mandatory material for certain lights. Beeswax candles were carried in front of the Pope and bishops, a practice believed to have originated in the secular practice of carrying candles before dignitaries of the Roman Empire (*Notitia Dignitatum Imperii*). When the Roman Emperor Constantine was converted to Christianity in 312/313, Eusebius wrote of 'pillars of wax' with which Constantine transformed night into day (*Vita Constant.* IV.22). At a synod held in south Gaul about 514, a minor order (acolyte) was conferred on an individual by presenting him with a candlestick and candle, and this rite was preserved until the 1900s. In England, beeswax was mentioned in Anglo-Saxon documents only after Christianity was introduced in 596 (Fraser, 1958).

The Christian festival of Candlemas – converted from the spring purification festival of the Romans – was held on 2 February, forty days after the birth of Christ. It came to be called the Purification of the Blessed Virgin Mary, and was also celebrated as the day when Christ was presented in the temple and hailed by Simeon as 'a light to lighten the Gentiles'. At the Candlemas service, the year's supply of candles was carried in procession, after the clergy had blessed them with the prayer that 'wherever they are lighted, our hearts, enlightened by the Holy Ghost, may be freed from all blindness ... [finally] we may enter into the everlasting light'. The earliest firm record of the use of beeswax candles *on the altar* as a part of required observance was in 1175, when two candles were described as 'the present custom of the papal chapel'. Figure 54.4a shows altar candles in 1482.

The following passage preceded a list of monetary values of swarms and colonies of bees, in a manuscript of the Gwentian Code of the Ancient Laws of Wales, first written down in the 1200s.

> The origin of bees is from Paradise* and because of the sin of man they came thence, and God conferred His grace on them, and therefore the mass cannot be said without the wax.

Large numbers of candles were used in Christian funeral rites. After the death of Henry V of England

Figure 54.4a Four candles burning on an altar (*Des Buch der heiligen Altväter*, Anton Sorg, 1482).

in 1422, clergy carried 1400 wax tapers in procession among the many lights held aloft on the route, along which 'every householder from London Bridge onwards had a servant holding a lighted torch at his door' (Dummelow, 1973).

The Reformation of the Roman Church in western Europe started during the early 1500s, and the Protestant Church proscribed candles for religious use. In England Thomas Cromwell, Henry VIII's Secretary of State, ordered the clergy in 1538 to 'suffer from henceforth no candles, tapers or images of wax to be set before any image or picture'. Cromwell was beheaded in 1540, but in 1547 the clergy were told to 'take awaie, utterly extincte, and destroy ... all candlesticks, tryndilles or rolles of wax'. In 1554 even altar lights were prohibited. In the Roman Church the use of candles continued as before.

In monasteries on Mount Athos in northern Greece, the churches are still lit only by beeswax candles made by traditional methods (Monk Moysis; see Nikiti, 1996). The same is true of St Catherine's monastery on Mount Sinai. The trindle, a roll of beeswax taper used for light in mediaeval Christian churches, still survives in widely separated places north of the Mediterranean region, including the Basque country in the north of Spain; Béarn in south-west France; Florina in Macedonia where many varieties are still produced by traditional methods; and Ayvalik near the coast of Turkey opposite Lesbos. Figure 54.4b shows a type used by a widow in Béarn.

*In some parts of Germany it was said that the bee was the only creature which came to earth unchanged and pure from Paradise; in the German language all animals except the bee devoured food (*fressen*), and perished (*krepieren*), but the bee – like man – ate food (*essen*) and died (*sterben*); see Ransome (1937).

Figure 54.4b A type of trindle, *cire des morts*, in its black velvet bag (photo: R. Chevet). Such a taper would have been lit in front of a widow while she prayed for her husband (Musée de la Cité des Abeilles, St Faust, Béarn, France).

The Paschal candle

The use of a special candle at Easter (Paschal, from Passover) was first mentioned in 384, in a letter attributed to St Jerome in northern Italy. He wrote elsewhere that candles were lighted throughout the East when the Gospel was read, not to put darkness to flight, but as a sign of joy (Fife, 1939, from Migne). He was, however, opposed to certain words in the prayer *Laus cerei* (Praise of wax) used in the dedication of the Paschal candle 'which described the life and work of bees in an amplified borrowing from Virgil'. The prayer also included the following passage attributed to St Ambrose, Bishop of Milan from 374 to 397.

> For now we see the splendour of this column, kindled to the glory of God from shining flame: a flame though it be divided into parts, yet suffers no loss of light, being fed from the ever melting wax that the mother bee brought forth to form the substance of this precious candle ... O truly blessed and marvellous mother bee!*

St Augustine, who was much influenced by St Ambrose, wrote in *De civitate Dei* between 413 and 426:

> Among bees there is neither male nor female. ... The wax of the candle produced by the virgin bee from the flowers of the earth is as a symbol of the Redeemer born of a Virgin Mother.

Another hymn in praise of the Paschal candle, dating probably from the 400s, referred to the bees that provide the wax for the candle, 'who produce posterity, rejoice in offspring, yet retain their virginity'. An Old English text (*MS Harl*. 2276 f. 30) has the same symbolism: 'Wax bitokeneth the maydenhed of Marie, Cristes modir'. The church fathers thus linked the wax of a candle with the virginity of the bees producing it, and with the Virgin Mary.

In mediaeval ecclesiastical literature of the Greek Orthodox Church there are also many references to the life of the bee (Nikiti, 1996), but the close association between the virginity of the bees and of Mary seems to be absent in the dogma of this Church.

Fife (1939) quoted verbatim a number of Latin texts of *Laus cerei*, and of other prayers that replaced this from the 700s which are referred to by their first word, *Exultet*: [He] will rejoice. Between about 900 and 1200, monasteries in southern Italy made a number of illuminated manuscript copies of the text in which the Paschal candle was blessed. As the priest read the words, he unrolled the manuscript down over the front of the pulpit, as in Figure 54.4c. Twenty of the surviving Exultet Rolls have a picture which came into the congregation's view when the passage about bees was read; it showed hives or bees, or the harvesting of honey combs. The illustration shown in Figure 54.4d is, unusually, integrated with the text. Several other Exultet pictures have been reproduced elsewhere; see Section 25.21. After the service, the remains of the Paschal candle might be broken up and distributed among the congregation, to be taken home as a protection against evil spirits and natural disasters.

A summary in the *Catholic encyclopedia* of 1907 stated that beeswax is regarded as typifying in a most appropriate way the flesh of Jesus Christ born

*This could perhaps have been the origin of the use of 'mother' and other female names for bees in certain European swarm charms of the 800s and 900s (Section 53.62) and some early Welsh texts; see Crane and Walker (1984/85).

Figure 54.4c Large Paschal candle burning at the Easter service of the Christian Church, and the priest reading from an Exultet Roll; MS made in Fondi, 1136, 7B 'Oramus Te, Domine, ut Cereus ... Conseeratus' (Bibliothèque Nationale, Paris, Nouv. Acq. Lat. 710.)

Figure 54.4d Illustration in the text of an Exultet Roll showing the exterior and interior of a cylindrical hive, and bees foraging (reproduced by courtesy of the Director and University Librarian, the John Rylands University Library of Manchester).

of a virgin mother (i.e. just as wax is born from the virgin bees); the wick of a beeswax candle symbolizes Jesus's soul, and the flame His divinity which absorbs and dominates both. The entry added 'this symbolism is still accepted in the church at large'.

54.5 The bee in religion

In many European and Mediterranean regions the honey bee (*Apis mellifera*) was regarded as having a divine origin. Gimbutas's 1974 study of the gods and goddesses of the matriarchal civilization of Old Europe between 7000 and 3500 BC (Section 54.1), discussed 'the epiphany of the Great Goddess in the shape of a bee'. She linked the bee's religious significance with *bugonia* – the supposed generation of bees from a dead bull or ox (Section 52.10) – the most appropriate time for which was said to be when the sun entered the constellation of Taurus, the bull. The representation of the Goddess in the shape of a bee in Figure 6.3b dates from 4000-3500 BC, and Gimbutas published further examples from the 6000s BC onwards; Ransome (1937) showed others.

In Egypt the bee was believed to have been created

from a tear of the sun god. A passage written in the 300s BC reads:

> Again, Ra [the sun god] wept. The water from his eye fell on the ground and became a bee. When the bee had been created, its task was [to work on] the flowers of every plant. That is how wax came to be, and how honey came to be, from his [Ra's] tears.
> (Papyrus Salt 825, BM 10051, col. 2, lines 1-7; translation based on Derchain, 1965)

In Ancient Greece a minor deity Aristaeus was credited with being the first individual to learn beekeeping, perhaps from one of the Muses. Ovid recounted the following story in about AD 8.

> Aristaeus was weeping because all his bees had died, leaving the unfinished combs. His mother, Cyrene, tried to console him, and told him that Proteus would tell him how to obtain fresh swarms. So together they went to seek Proteus ... He told Aristaeus that he must bury the carcass of a slaughtered ox, and that from it he would obtain what he wanted, for when the carcass decayed, swarms of bees would issue from it. The death of one thus produced a thousand lives. (*Fasti* I.363ff.)

Porphyry (AD 233 to c. 304), who studied in both Athens and Rome, wrote:

> The Ancients gave the name of Melissae (bees) to the priestesses of Demeter who were initiates of the chthonian [underworld] goddess; the name Melitodes to Kore herself; the moon (Artemis) too, whose province it was to bring to the birth, they called Melissa, because the moon being a bull and its ascension the bull, bees are begotten of bulls. And souls that pass to the earth are bull-begotten. (*De ant. nym.*: 18; quoted by Ransome, 1937: 107)

According to the above passage both the bee Melissa and the bull belonged to the moon, and both were periodically regenerated. Also, souls were bees, and Melissa drew them down to be born. In the Fourth of his *Georgics* (219-227), Virgil went further in his sanctification of bees.

> Some have taught that the bees have received a share of the divine intelligence, and a draught of heavenly ether; for God, they say, pervades all things, earth and sea's expanse and heaven's depth; ... yea, unto Him all beings thereafter return, and, when unmade, are restored; no place is there for death, but, still quick, they fly unto the ranks of the stars, and mount to the heavens aloft.

Bessler (1886) and Ransome (1937) referred to bee gods in south-east Europe. In the Caucasus, the Ossetens worshipped a bee goddess Meritta or Merissa, and Merime – mother of the Circassians' god of thunder – was a godmother and patron of bees. According to St Augustine, the Romans had a goddess of bees, Mellona or Mellonia (*De civitate Dei* 4.34; quoted by Ransome, 1937).

Early tree beekeepers in the middle Volga region prayed to the 'God of Bees' (Section 16.21), and among the Mordva the eldest son of Ange Patyai – their mother-goddess – was the Beehive God, the chief protector of bees; Ransome (1937) gave more information. Poles, Livs and Silesians farther west had a bee god Babilos (or Bybulus) and a bee goddess

Figure 54.5a St Sossima (left) and St Savatii, patrons of beekeeping in Ukraine, taking a swarm (Armbruster, 1928).

Austeia. The Russians' bee god was Zosim, who was also said to have discovered beekeeping. He may possibly have been transformed into St Sossima (Figure 54.5a), one of the two patron saints of beekeeping recognized by Ukrainian Christians.

It was often believed that a wise philosopher, eloquent speaker or inspired writer owed his outstanding ability to the fact that bees had alighted on his mouth in infancy. Men believed to have been favoured in this way include Plato, Sophocles, Xenophon, Virgil and, in Christian times, St Ambrose and St Basil. A painting on the high altar of St Ambrose's church in Milan shows the saint as an infant in his cradle, with bees flying round his head. St Ambrose was widely regarded as the patron saint of beekeepers and, in western Europe north of the Alps some time after his death, he became associated with a tall skep characteristic of parts of that region, as in Figure 54.5b. In northern Spain, the Virgin of Valvanera was considered as the patron of beekeepers since the late 800s (Albariza, 1988). Moreaux (1962) wrote about many other patron saints of beekeeping.

Figure 54.5b Limewood statue of St Ambrose with a skep, made in the 1600s and at one time kept in a London house (photo: M.P. Davey).

Much less is known about other bees in relation to religion except *colecab*, the stingless bee *Melipona beecheii*, kept in hives by the Ancient Maya in Mesoamerica. The Maya religion was a contract between man and the gods who helped him in his work – such as honey production – and expected payment in the form of offerings. The Maya pantheon included Noyumcab the great god of *colecab*, his wife Kauli Oxtch, and their virgin daughter Kolebil X'pohl. These deities were believed to live in ancient Maya cities: Coba (Classic), Uxmal (Late Classic) and Mayapan (Post-Classic), respectively. In Figure 54.5c the god on the left is about to enclose a bee in a rectangular hive which is on top of a box marked *cauac*, honey. On the right, the bee is already enclosed in the hive and cannot be seen. See also *Bee ceremonies* near the end of Section 30.22.

There were also *bacabs* (mediators), and some of them were the patrons of beekeeping to whom beekeepers made their offerings of honey – usually in advance – to ensure the prosperity of their bees. A footnote on page 391 comments that some beekeepers identified the (larger) honey bees, introduced about 1900, with Ah Mucan Cab, the god of their *colecab*.

Representations of the bee

From the start of the Dynastic period in Egypt in 3100 BC, the honey bee (*Apis mellifera lamarckii*) and the sedge plant were incorporated in the titulary of the Pharaoh, who was regarded as divine. The honey bee was later considered to symbolize Lower Egypt (footnote in Section 20.7) – where the delta still provides extensive bee forage – and the sedge Upper Egypt. Countless representations of the bee and sedge can still be seen in Egypt and in Egyptian Museums elsewhere. A few of the earliest are reproduced in Figure 6.3c and described in the text. Figure 54.5d shows a typical later example.

Numerous representations of the honey bee are known on monuments, jewellery and coins from early civilizations in Ancient India, Crete, Greece, Etruria and elsewhere, and some have a religious significance. They are described and illustrated in many publications (Cook, 1895; Ransome, 1937; Armbruster, 1952; Nivaille, 1978/79; Münz Centrum, 1980; Crane, 1983a). Many, but not all, were made by peoples who kept bees in hives. Section 52.2 discusses some early anatomical drawings of the bee.

In China during the Shang dynasty (*c.* 1523 to *c.*

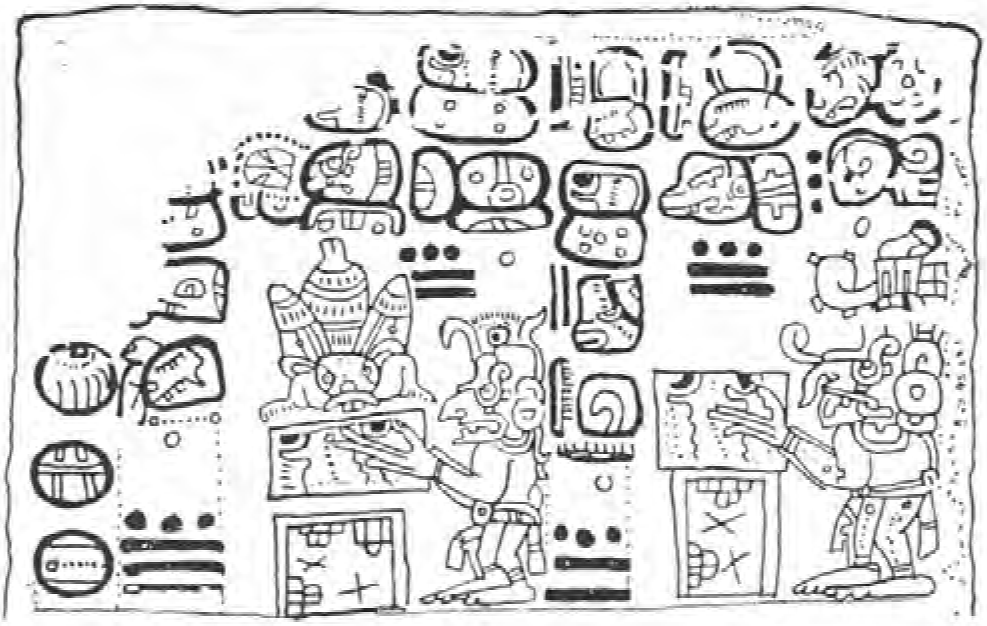


Figure 54.5c Part of page 104 of *Codex Tro-Cortesianus* (Villacorta & Villacorta, 1977). The lower part shows two bee gods facing left, each with a hive; the text explains what they are doing.

Figure 54.5d Stone relief in a temple at Karnak, Luxor, Upper Egypt, showing (centre) the bee and the sedge in the titulary of the Pharaoh, 1400s BC (photo: E. Crane).

1028 BC), Emperor Trou Yu had bees on his flag 'as an auspicious omen' (Appendix 1); these were probably *Apis cerana* or *A. dorsata*.

54.6 The concept of the honey bee community in religious and secular life

Throughout the generations, there seem to have been people who felt a special affinity with bees and saw a link between their own way of life and that of a bee community. In the Hebrew scriptures the book of Proverbs – attributed to Solomon (900s BC) – refers in the Authorized English version to the ant but not the bee. However, in a version written about 100 BC for Greek-speaking Jews in Alexandria, the passage 'Go to the ant, thou sluggard ...' continues: 'Or go to the bee and see how diligent she is and how considerable the work she does. Kings and commoners take what she yields for their health; she is sought after

and revered by all, her strength may be feeble, but because she does homage to wisdom she wins respect.'

From the time of Aristotle onwards, writers commented on the highly organized honey bee society, which *Historia animalium* described as follows.

> They expel from the hive all idlers and unthrifts. As has been said, they differentiate their work; some make wax, some make honey, some make bee-bread, some shape and mould combs, some bring water to the cells and mingle it with the honey, some engage in out-of-door work. At early dawn they make no noise, until some one particular bee makes a buzzing noise two or three times and thereby awakes the rest; hereupon they all fly in a body to work ... until at last some one bee flies round about, making a buzzing noise, and apparently calling on the others to go to sleep; then all of a sudden there is a dead silence. (IX.40.627a)

A translation of the equivalent passage in Virgil's *Georgics* (IV.156-168) is quoted in Section 24.1, and the *Aeneid* (I.433-440) included a shorter account.

In the 300s-400s many fathers of the Christian church wrote in praise of the honey bee community, emphasizing the orderliness of its life and work as described in Aristotelian writings, and citing it as the model for a Christian community. They also incorporated the concept of the virginity of the bees from Aristotle's works, for instance in *De generatione animalium* (III.10.759b): 'None of them [the bees] has ever been seen copulating, whereas this would have often happened if the sexes had existed in them.' St Ambrose wrote:

> Let, then, your work be as it were a honeycomb, for virginity is fit to be compared to bees, so laborious is it, so modest, so continent. The bee feeds on dew, it knows no marriage couch, it makes honey. The virgin's dew is the divine word, for the words of God descend like the dew. The virgin's modesty is unstained nature. The virgin's produce is the fruit of the lips, without bitterness, abounding in sweetness. They work in common, and their fruit is in common.

St Jerome (*c.* 342-420) in Italy was another who exalted celibacy, and the Sacramentary of Galasius I, Pope from 492 to 496, praised the bees in which 'virginity becomes fruitful without giving birth'. St Augustine, St Basil and St Tertullian wrote similarly. The use of beeswax candles in the churches (Section 54.42) was based on this concept. Abbot Sturm, who was appointed Abbot of the monastery at Fulda in Germany in 744, also taught that the virgin bees showed an example of an ordered Christian community. In *Liber apum seu universale bonum* (c. 1259), the Dominican monk Thomas de Cantimpré compared the life and duties of Christians (notably of the clergy and monks) with the life of the bees. As there was only one king bee, so there should be only one king or pope. Since the king bee does not use his sting, bishops should be mild. The lay brothers were compared to the drones. Both the unity and the virgin purity of the bees should serve as an example to the monks. Stillness should fall upon the convent in the evening, as it does upon the hive.

Ransome (1937) quoted the above, and similar texts written in later centuries. For example Ibn-al-Athir of Mosul in Mesopotamia (d. 1232) compared Muslim believers to bees: bees 'did not eat of food gathered by others, and were obedient to their prince'.

A Dutch book on 'the Roman bee hive' was published in 1569. On the title page (Figure 54.6a) the papal tiara was made into a skep from which the Pope – as the king bee – surveyed the other bees who with shorn heads, mitres and cardinals' hats were flying round him, hearing confessions, burying the dead and saying Mass. The book was followed in 1652 by one in English, possibly published in Paris: John Gage's *The Christian sodality, or Catholick hive of bees sucking the hony of the Churches prayers from the blossomes of the Word of God, blowne out of the Epistles and Gospels of the Divine Service throughout the yeare.* Only three copies of the book are known.

In northern Europe the Protestant Christian Church – created after the Reformation – did not promote the bee society as a model, but this concept was adopted in political circles. Several authors drew on passages written in Aristotle's time to describe an ordered secular human society based on that of the bees. In 1530 François de Rohan wrote in *Fleur de vertu* (Figure 54.6b):

> One can attribute the virtue of justice to the king of the honey bees, who disposes and gives orders on these matters with reason. For some bees are ordered to go to the flowers to make honey. Others are ordered to work the honey, others are detailed to accompany the king. Some are ordered to fight, for naturally they have great wars among each other, for one wants to take the honey from the other. None ever leaves the hive before the King, and each one has a great respect for him.

Figure 54.6a The bee hive of the Roman Church, as portrayed on the title page of a 1581 book by Philips van Marnix, Heer van St Aldegonde, first published in 1569 as *Den byencorf der H. Roomsche Kercke*.

¶ Fleur de vertu

ceſt avoir auctorite de la faire. La secõde quil entende bien la choſe ql veult iuger: La tierce quil vueille iuger ſelon raiſon.

¶ Exemple.

Et ſe peult approprier la vertu de iuſtice au roy des mouſches a miel qui ordonne et diſpoſe de ces choſes avec raiſon: car certaines mouſches ſont ordõnees pour aller aux fleurs pour faire le miel. Aucunes autres ſont ordonnees a labourer le miel/ les autres ſont deputees a acompaigner le roy. Au

Figure 54.6b Page of *Fleur de vertu* by F. de Rohan in 1530, describing the community of honey bees.

In a book on divine weeks and works (1578), Seigneur du Bartas wrote: 'Where's the state beneath the firmament / That doth excel the bees for government?' John Lyly wrote similarly in *Ephues and his England* (1580), and Michel de Montaigne in his *Essays* (1580-1588): 'Is there a society regulated with more order, diversified into more charges and functions, and more consistently maintained, than that of the honey bees?' (see Frame, 1958).

The best known passage, written in 1599, is in Shakespeare's *King Henry V* (I.2).

They have a king, and officers of sorts:
Where some, like magistrates, correct at home;
Others, like merchants, venture trade abroad;
Others, like soldiers, armed in their stings,
Make boot upon the summer's velvet buds;
Which pillage they with merry march bring home
To the tent-royal of their emperor:
Who, busied in his majesty, surveys
The singing masons building roofs of gold,
The civil citizens kneading up the honey,
The poor mechanic porters crowding in
Their heavy burdens at his narrow gate,
The sad-ey'd justice, with his surly hum,
Delivering o'er to executors pale
The lazy yawning drone.

Several political satires in the 1600s and 1700s were based on the life of bees. John Daye's *The parliament of bees* (1641) had Mr Bee, the leader of the hive, acting as Pro-Rex. Bernard de Mandeville's *The fable of the bees* (1714) was an influential satire on the emerging capitalist economy. But in general the honey bee community was still regarded in Europe as a model – provided by God – of stable government, good management and industry. From the mid-1600s honey bees were also increasingly studied as crea-

tures that could be advantageously managed by rational means; Raylor (1992) discussed several aspects of this development, which continued through the 1700s and into the 1800s without any appreciable loss of reverence. The Industrial Revolution in the 1800s accentuated the regard for bees as symbols of unremitting work, and also of thrift.

During the 1900s, new scientific techniques led to more and more discoveries about bees and their lives, which became a source of increasing wonder as a part of the natural world. In the late 1900s there was also a growing concern for the well-being of the environment of the whole planet, and the honey bee colony became an archetype of a community which uses environmental resources in a way that conserves them and actually increases them through pollination.

54.7 Annex: sources of information on early beliefs about bees

The following publications refer to beliefs about bees and their products, and many are cited elsewhere in this book. The Bibliography gives complete references.

J.G. Bessler (1886) *Geschichte der Bienenzucht*
H.M. Ransome (1937) *The sacred bee in ancient times and folklore*
B.F. Beck (1938) *Honey and health*
R. Chauvin (ed.) (1968) *Histoire, ethnographie et folklore* (Vol. 5 of *Traité de biologie de l'abeille*)
R. Büll (1970) *Wachs und Kerzen im Brauch, Recht und Kult*, Vol. 1, Part 10, of *Vom Wachs: Hoechster Beiträge zur Kenntnis der Wachse*

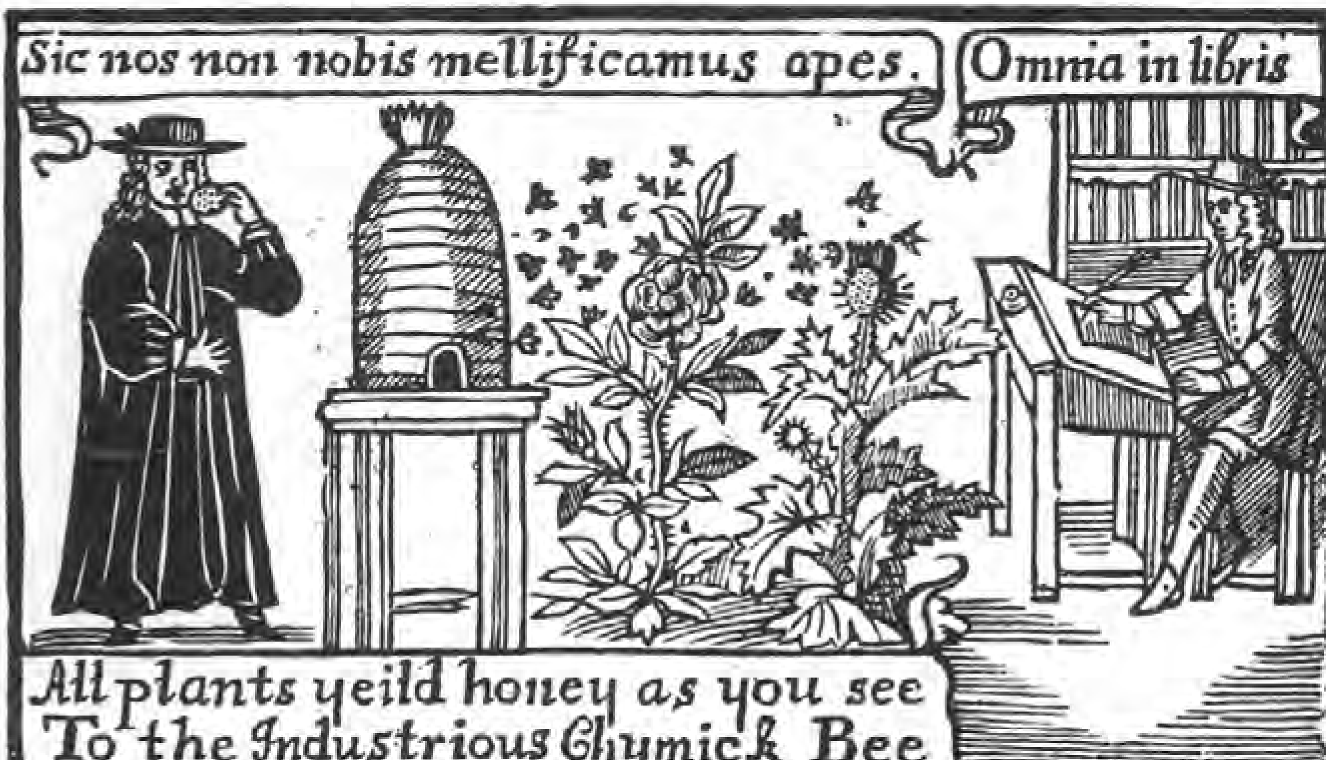


Figure 54.6c Woodcut dating from the late 1600s. The heading is a Latin motto: 'So we the bees make honey, but not for ourselves.' The cleric on the left wears Geneva bands, like those of Swiss Calvanists; he is eating a piece of honeycomb. The cultivated rose and the wild thistle symbolize the extremes of plant life, all yielding honey to the bee. On the right, 'Everything is to be found in books' refers to the scholar in his study below. He, like the bee, gathers knowledge from all available sources and stores it for use by others.

When Hilda Ransome's book was published, Dr Beck had already prepared an extensive work with a similar organization and content, entitled *Bees and mankind*. The appearance of her book made it uneconomic for Dr Beck to publish his larger one, but Fife (1939) was able to see the manuscript. Beck's *Honey and health* published in 1938 contained only a small part of his historical material, and even that was much shortened in the second edition (Beck & Smedley, 1944).

Some more general popular books also discuss these subjects, for instance by Marchenay (1979), Crane (1980a) and Free (1982). Regional studies include the following.

Ancient Egypt

J. Baltrušaitis (1967) *La quête d'Isis*

Christianity and Islam

A.E. Fife (1939) *The concept of the sacredness of bees, honey and wax in Christian popular tradition*
T. Fahd (1968) *L'abeille en Islam*

Ancient Greece and Rome

A.B. Cook (1895) *The bee in Greek mythology*
C.R. Osten-Sacken (1894) *On the oxen-born bees of the ancients (bugonia)*
H.M. Fraser (1951a) *Beekeeping in antiquity* (1st ed. 1931)

Europe

J.G. Bessler (1886) *Geschichte der Bienenzucht*
C. Haberland (1881) 'Biene und Honig im Volksglauben'
T. Edwardes (1908) *The lore of the honey-bee*
F. Reichlein (1950) 'L'abeille et le folklore'
W. Menzel (1842) 'Monographie der Biene'
O. Pauls (1914) 'Die Biene in der Mythologie ...'
A. Lundblom (1959) *Honungsbiet i saga och sanning* [Scandinavia]

Africa

C. Seyffert (1930) *Biene und Honig im Volksleben der Afrikaner*
H. Pager (1975a) *Stone Age myth and magic ...*
B. Woodhouse (1984) *When animals were people*

Asia

D. Goldsworthy (1978) *Honey-collecting ceremonies on the east coast of North Sumatra*
C.G. & B.Z. Seligmann (1911) *The Veddas*

Australia

B. Spencer (1928) *Wanderings in wild Australia*

APPENDIX 1

China: References to Bees, Beekeeping, Honey and Beeswax, from 2000 BC to AD 1600

Sources are referred to by initial letter of the author, and the year (e.g. M53), and are listed at the end. Many early dates and some other details are uncertain; see Section 29.2.

	c.1994 – c.1523 BC, Hsia (Xia) dynasty	
c.2000	Shen Nung discussed the medicinal value of honey.	M53
	c.1523 – c.1028, Shang (Yin) dynasty	
	Words for honey and bee inscribed on tortoise shells.	F90
1400-1000	Earliest pictograph for honey in an inscription on bones.	M81
	Emperor Trou Yu had bees on his flag, as an auspicious omen.	KYF
	c.1027 – 265, Chou (Zhou) dynasty	
	Word for maltose (but none for honey) appeared in the early Liu style of writing.	K68
1100s	*Erh ya* [Nearing the standard] mentioned bees, but not honey. A later edition is quoted in Section 10.31.	R37
800-500	[*Book of songs*], the earliest collection of poetry, mentioned bees.	M81
between 770 and 221	Representation of a bee on a bronze helmet.	T95
c.500	Beeswax used in lost-wax casting (Section 49.43).	
c.500	In later part of Chou dynasty, earliest authentic record of honey as food.	O52
300s	Prince Yueh sent honey to the Prince of Wu, in return for a piece of land.	K68
300s	Distinct term for honey in written language.	K68
	221 – 207, Ch'in (Qin) dynasty	
c.220	A book on Chinese medicine listed honey as the most beneficial medicine: 'those who often take honey can keep fit, honey can cure indigestion, it can be used in medicaments to bind other ingredients together.'	M81
200s:	Sugar cane introduced into south China.	B67
	Honey and maltose distinguished, e.g. 'this taste is not like maltose or honey'.	K68
	A book [*Regulations on morality*] said 'children should nourish parents with honey'.	KYF
	303 BC – AD 220, Han dynasty	
100 BC or later	[*Book on rites*], the earliest book on etiquette, mentioned honey and bees.	M81
25 BC	A book commented 'bees nest in the mountains, where there is honey'.	KYF
AD 1-100	Honey among the main imports from the west, obtained by bartering silks.	K68
25	Emperor Kwan gave 120 catties (73 kg) of honey to a friend.	K68
25-150	East-Han dynasty, during which the author of a book [*How to acquire wealth*] mentioned beekeeping as one method; he was sometimes named as Fan-li.	O52
100	The earliest Chinese dictionary, [*About words*], had entries for honey and bees.	M81
100-121	Siu Tren in [*Literature and character explanation*], the earliest literary book, said 'honey is a sweet food'.	KYF

100-200	*Shen nung pĕn tshao ching* [Pharmacopoeia of the heavenly husbandman] cited honey, beeswax and bees as 'medicines of superior quality', and rock honey as a remedy for various diseases.	K92
158-167	In Hanyang, Kang Tru lived from keeping bees and pigs, and more than 300 men came from all parts of the country to learn beekeeping, according to the Kai Si story by Huang Pu Me in the 200s.	KYF

220 – 280, Three kingdoms: Shu, Wei, Wu

	Beeswax used for seals, as a finish for wooden shoes, and for printing on silk.	C93

265 – 420, Ts'in (Chin) dynasty

	Government proclamation of this dynasty encouraged productivity in beekeeping: 'Beekeepers can collect ten measures of honey as a maximum: if any person can collect two pints (1.6 kg) more he will be rewarded with ten bushels of rice [360 litres].'	K68
265-290	Chang Hwa's [*Natural science book*] described a method for getting a swarm to occupy a bait hive (quoted in Section 29.2), and also beeswax collection from *A. dorsata* nests on cliffs (Sections 5.5, 15.22).	K68
276-324	Life of Kuo P'o, who wrote a short poem in praise of honey.	R37
200s-300s	Quo Fu wrote in the poem [*Bee*] that honey 'is similar to molasses when normal, and to leaf lard when coagulated'. He referred to bees 'building golden houses, founding valuable rooms [cells]', and said that 'the front [of the hive] should be directed to the sun'.	KYF
*c.*300	Honey (wax?) used for polishing metal in the household of the Minister of Agriculture.	K68

420 – 581, Southern and Northern dynasties

420-479	Treng Chi Chu wrote in *Ung Chya* [Geography]: 'In July, August, bees often come. A bee comes first to seek the place, and is recognized and seized by the people [with?] the log hive. The hive is smeared with honey. The flying bee discovers the smell and alights. After 3-4 visits to it, all colony will come.'	KYF
500	After this date, records of beekeeping occur in district reports, and in books on medicine and natural science.	M81
500	When Tao Hua Chun retired from official life, the Emperor gave him a quart of honey a month (1.6 kg) as his 'drug of longevity'.	K68

618 – 906, T'ang dynasty

	Duan Chenshi wrote *Youyang zazu* in which drones were described.	C93
	Frescoes of T'ang royal tombs show beeswax candles, and their production was described.	C93
600-800	Honey was used mixed with opium.	R37
700s on	As a diagnostic test for human diabetic glycosuria, some of the patient's urine was placed near a nest (of *Apis cerana*), and a watch kept to check whether bees were attracted to it by its sugar content.	N70
868	A printed Buddhist book survives from this date.	

960 – 1279, Sung dynasty

983	Li Feng and others completed *T'ai-ping-yü-lan*, an 80-volume encyclopaedia compiled by Imperial command. It quoted Chang Hwa's account of beeswax collection (AD 265-290 above).	F55
1000	Beekeeping practice was described n more detail than previously. Bees were kept in wooden tubs and bamboo 'cages'; honey and wax were cut out once or twice a year, in late autumn and early spring.	M81

1000	Wang Ulu* wrote in Volume 14 of [*Small animals*]: In the pagoda Wanhua of the Sung dynasty, many bees were kept by *bonzes* [Buddhist priests]. Confucius asked: 'Bees have a queen, how is it?' The reply: 'It is greyish, a little bigger than normal bees ...'; in summary: The body of the queen is greyish, larger than worker bees, and venomless. The queen gives birth to young queens in queen cells. The destruction of queen cells may control swarming. The queen is supported by worker bees when swarming. The presence of the queen secures the colony, and her absence makes it troubled. The honey harvest taken should be rational, neither too much nor too little.	KYF
1000-1100	Wang Yuan-Chih* wrote *Fêng chi* [Beekeeping record], which included the following passage (translated by Fan Tsung Deh). 'There were many bees in Shiang Ho Temple in Shan Yu a district of Honan province, China. When I questioned a monk, he answered me as follows: Q. What is the appearance of the king bee? A. The king bee is larger than the common bees. His colour is pale blue. Q. How does the king bee rule his people? A. The king bee does not sting anyone. He knows nothing. Q. Where does the king bee reside? A. When they build their nest, there are some king cells like chestnuts where His Majesty resides and lays 3-5 eggs into the cells which in turn become kings. They divide every year. When they swarm, bringing a king with them, they are like a jar or a fan. If the swarm has a king, they do not sting. If the king were lost, they must disperse. When we cut away their honey, we don't cut it too much, or they become hungry and dwindle and we don't cut it too little, or they become lazy. I prefer the king who does not sting; it seems he has virtue. I like it that the children of the king become kings in turn, as if they were the royal family's descendants. I like it that the bees don't sting anyone in front of the king, as though there is a law to obey. And I like the medium honey cutting, which resembles a ten per cent tax by the government.'	N58
1233	Wang-E, scholar and historian, mentioned a presentation to the Emperor which included honey (Section 46.41).	H93

1260 – 1368, Yüan dynasty

	Chen Chuan Chi and others described honey collection, presumably from *A. dorsata*.	K68
	Li Ji wrote *Yulizi, lingqui zhagren*, describing beekeeping through the seasons, including the uniting and dividing of colonies, and control of enemies.	C93
1271	The Yüan emperor established a Board of Agriculture.	N84
1273	The above Board printed *Nung snag chi yao* [Fundamentals of agriculture and sericulture], which included beekeeping. It was immediately distributed all over the country (then the northern provinces and Szechwan), but no copy survives.	N84

1368 – 1644, Ming dynasty

1490-1570	Li Su Tren wrote *Ben cau Kang mu*, saying 'Honey is made tightly, therefore called honey'.	KYF
1553	Wang Shi-Chin completed *Chi-pei-yau-tan*, which referred to the families of Yau-yue who regarded a day on which their bees swarmed as unfailingly lucky, so they regulated their lives by observing their hives.	R37
1596	In *Pên Tschao Kang Mu* [Great pharmacopaeia], Li Shih Chen tried to explain the origin of the word for honey.	K68

* The passages from writings attributed to Wang Ulu and Wang Yuan-Chi should be read in the light of the footnote on page 590, about references to the king or queen bee in Ancient Greek texts.

Sources

B67 Baxa & Bruhns (1967)
C93 Chen Yaochun (1993)
F90 Fang Yue-zhen (1990)
F55 Friedmann (1955)
H93 Hok-Lam Chan (1993)
K68 Kellogg (1968)
K92 Konishi (1992)
KYF Kung Yi Fey (date not recorded)
M53 Maa (1953)
M81 Ma Deh-Feng & Huang Wen-Cheng (1981)
N58 Needham (1958)
N70 Needham (1970)
N84 Needham (1984)
O52 Osborn (1952)
R37 Ransome (1937)
T95 Tian Xu-Jun (1995)

APPENDIX 2

Some Beekeeping Museums

This Appendix gives names and addresses of some beekeeping museums, and general museums with material on the history of beekeeping. Entries marked* were confirmed in 1996. Earlier lists have been issued (Crane, 1979, 1983a, 1990a), and a detailed guide is being published by Apimondia, IITEA, Bd Ficusului 42, Bucharest 71544, Romania.

Museums listed differ greatly in the number of historical items held, and in the proportion of beekeeping material on public display. They also vary in their days and hours of opening, and material in certain museums can be seen only by appointment. The list does not include exhibitions on modern beekeeping or the life of bees.

Argentina

*Museo de la Plata, Paseo del Bosque, 1900 La Plata, BA

Museo Apícola Nacional e Internacional, c/o Sociedad Argentina de Apicultores, Rivadavia 717, Piso 8, 1392 Buenos Aires

Australia

Beekeeper's Museum, Sandhurst Town, Bendigo, Vic.

Austria

*Österreichisches Bienenzuchtmuseum, 2304 Orth an der Donau; also collection in Landschaftsmuseum Schloss Trautenfels

Belgium

*International Apimondia Beekeeping Museum, Nekkerspoelstraat 21, 2800 Mechelen

*Musée de l'Abeille, Rue du Bibet 9, 4040 Tilff

*Bijenteeltmuseum 'Apicultura', Heikantstraat 51, 2180 Kalmthout

Canada

*Musée de l'Abeille et les Ruchers Promiel, 8862 Boulevard Ste Anne, Chateau Richer, Quebec, G0A 1N0

Ontario Agricultural Museum, POB 38, Milton, Ont., L9T 2YE

Czech Republic

*Zemedelske Muzeum (Agricultural Museum), Kačina, nr Kutná Hora

Denmark

*Herning Museum, Museumsgade 1, 7400 Herning

Finland

Apicultural Museum, Hattula

France

*Musée National d'Histoire Naturelle, 57 Rue Cuvier, 75231 Paris

*Musée des Arts et Traditions Populaires, route du Mahatma Gandhi, 75016 Paris

*Musée de l'Apiculture d'Alsace, rue Gay-Lussac 1, ZA, Eckbolsheim, BP06, 67038 Strasbourg-Cedex

*Musée des Arts et Traditions Apicoles, 06540 Fontan, Alpes-Maritimes, with associated Routes du Miel to visit surviving early apiaries.

Germany

*Deutsches Bienenmuseum Weimar, Ilmstrasse 3, 99425 Weimar

*Armbrustersammlung, Stadtmuseum Berlin, Abteilung Bienenmuseum, Domäne Dahlem, Königin-Luise-Strasse 49, 14195 Berlin-Zehlendorf

*Bienenkunde-Museum, Altes Rathaus, 7816 Münstertal/Schwarzwald

*K.A. Forster Bienenmuseum, Vöhlin-Schloss, 89257 Illertissen, Bayern

Bayerische Landesanstalt für Bienenzucht, Burgbergstrasse 70, 8520 Erlangen

Greece

*Florina Cultural Club Beekeeping Museum, 53100 Florina

Hungary

*Néprajzi Museum, Konyves Kalmankorut 40, Budapest VIII

*Kisállattenyésztési Kutatóintézet, Méhészet, 2101 Gödöllo

India
*Central Bee Research and Training Institute Museum, 1153 Ganeshkind Rd, Pune 411016

Italy
*Osservatorio di Apicoltura 'Don Giacomo Angeleri', Strada del Cresto 2, 10132 Reaglie-Torino
*Museo Apistico Didattico, via Memegardo 12, 22070 Bregnano, Como
*Museo dell'Apicoltura, Gruppo la Cappelletta, Via Stignani, 20081 Abbiategrasso, MI
*Plattner Bienenhof Museum, Costalovara 15, 39059 Soprabolzano

Japan
*House of Honeybees, 776 Tsubakibora-Nakano, Gifu-shi, Gifu
*Azuma Museum of Bees, 1842-2 Sabi, Tondabayashi-shi, Osaka

Korea
*Museum of Agricultural and Science History, Seoul National University

Mexico
Museo Regional de Guadalajara

Netherlands
*Stichting Drents Bijenteeltmuseum, Hoeve Bekhof, de Hoek 5, Vledder
*Het Nederlands Openluchtmuseum, Schelmseweg 89, Arnhem
*Bijenteeltmuseum 'De Zoete Inval', Hogestraat 1, 4011 KA Zoelen

Norway
Norges Birøkterlags Museum, Bergerveien 15, 1352 Billingstad

Poland
*Skansen Pszczelarski, ul Poznanska 35, 62-020 Swarzedz
*Muzeum im. Jana Dzierżona, Ul. 15 Grudnia 12, 46-200 Kluczbork
*Pasieka Uli Klodowych, Muzeum Wsi Opelskiej, Opole-Bierkowice

Portugal
O Museu de Ovar, Ovar

Romania
*Expozitia Permanenta de Apicultura Apimondia, Bd Ficusului 42, Sect. 1, Bucharest

Russia
*Central Beekeeping Research Station, Rybnoe, Ryazan

Slovenia
*Muzeji radoviijiske obcine, 64260 Radovljica, Linhartov trg 1

Sweden
Biodlingsmuseet, Hembygdsparken, 29700 Degeberga

Switzerland
*Naturhistorische Museum Bern, Bernastrasse 15, 3005 Bern

United Kingdom (UK)
*IBRA Collection of Historical and Contemporary Beekeeping Material, 18 North Road, Cardiff, CF1 3DY
*Museum of English Rural Life, University of Reading, Whiteknights, Reading, Berks RG6 2AG
Welsh Folk Museum, St Fagans, Cardiff, CF5 6XB
Scottish Agricultural Museum, Ingliston, Midlothian (small collection)

United States (USA)
Honey Acres, NI 557, Hwy 67, Ashippun, WI 53004
Mangum Museum, contact Wyatt Mangum, 1403 Varsity Drive, Raleigh, NC 27606
Ohio Agricultural Research and Development Center, Wooster
Hewitt Museum, Richards Rd, Litchfield, CT

Venezuela
*Museo Nacional de Apicultura, Ignacio Herrera (MUNAPIH), Parque La Isla, Mérida

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Index of Personal Names

To save space, this Index includes rather few names after the year 1900, and personal titles and forenames are omitted. Ch = Chapter; § = Section. A page or Section with a relevant Figure is in bold type. * indicates that the name is in the Bibliography.

Index of Peoples

A people whose name is based on the name of a country may be found through the Geographical Index. A people referred to only once in the text is not included here. § = Section. A page or Section with a relevant Figure is in bold type.

Geographical Index

Most places are indexed under current English names. Ch = Chapter; § = Section. A page or Section with a relevant Figure is in bold type; a Chapter indexed also includes Figures.

Abbreviations

Beekeeping	hive beekeeping unless otherwise specified
BKAs	Beekeepers' Associations
honey drinks	honey-based drinks, usually alcoholic
m.f.	movable-frame
stingless	stingless bees, not honey bees
trad.	traditional

Subject Index

The Geographical Index leads to information relating to individual countries, etc.
Ch = Chapter; § = Section; App = Appendix. A page or Section with a relevant Figure is in bold type; a Chapter indexed also includes Figures.